PRODUCTIVITY ACCOUNTING IN SELECTED NIFTY 50 COMPANIES

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CERTIFICATE

I feel great pleasure in certifying that the thesis entitled "**PRODUCTIVITY ACCOUNTING IN SELECTED NIFTY 50 COMPANIES**" embodies a record of the results of the research work carried out by **Priya Taparia** under my guidance. She has completed the following requirements as per Ph.D. regulations of the University.

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PREFACE

Productivity and the growth of productivity must be the first economic consideration at all times, not the last. That is the source of technological innovation, jobs and wealth" - William E. Simon

The growth of an economy largely depends on the productivity and its growth in an organisation. It sows the seeds for technological innovation, employment creation and ultimately increasing the wealth of a country.

The productivity can be viewed by different persons in different aspects. If an organisation which largely depends on the material as input will ensure that its material productivity is higher with minimum wastage of material. A labour oriented organisation tries to optimise the use of its labour which resulted in improvement in labour productivity. In the same way, the capital intensive organisation tries to utilise its capital resources in an efficient way i.e. no misutilisation of capital. Therefore, the essence of productivity is different to different people, but it has been marked as a continuous and significant issue to look after even in this contemporary times. The productivity of an organisation forms the basis of economic development of a country and increases the standard of living of the persons of the society. It also affects each and every sector e.g. government, business, workers, society, shareholders, customers, environment, etc.

The present study is based on the partial as well as overall productivity of the selected companies of Nifty 50. Nifty 50 is the standard Indian stock market representing 50 of the largest Indian companies listed on NSE. It comprises of sectors such as automobile, energy, information technology, metals, pharmaceutical, refineries, etc. which to great extent represents the Indian economy. Thus, productivity of these sectors has a significant impact on the economic environment of India.

The present study has been divided into eight chapters. The first chapter of ***"Introduction"*** *includes introduction of productivity, its meaning, definitions and*

its evolution in India. The purpose and the importance of productivity have also been discussed. It further explains the concept of overall productivity and partial or factoral productivity. It highlights the relationship between productivity and production, productivity and profitability. This chapter also includes productivity measurement models, viz., Production Function Model, Economic Utility Model, Measurement through Financial Ratios, Surrogate Model, Systems Approach Based Model, Production Based Model and Productivity Accounting Model. Approaches for measuring productivity and difficulties faced while measuring the productivity of a concern have also been described here. At last it explains the factors affecting productivity and the techniques for the improvement of productivity.

*The second chapter **"Review of Literature"** presents a brief reviews of various studies and research papers related to the topic. The main objectives behind the review of literature are to understand conceptual framework of productivity, methodologies applied for measurement of productivity and suggestions given for improvement in productivity. This chapter presents chronological review of literature and has been categorised into two parts according to the level of literature i.e. Reviews of International Level Literature and Reviews of National Level Literature. After that, it helps in identifying the research gaps that provide a base for this research.*

*The third chapter **"Research Methodology"** is the blueprint of this research study which states the research problem and best suited methodology to conduct this research. It covers the objectives of the research and the framework of the research which includes the selection of sample, type of research conducted and research design. Research design includes collection of data, period of study, selection of base year, model to be used, variables used, revaluation of output and input and lastly calculation of index numbers and conversion factors. Research hypotheses have been developed and Chi-square Test and Kruskal Wallis One Way Analysis of Variance Test have been used to test these hypotheses. Other statistical tools and techniques used in the study are Mean (Average), Standard Deviation, Coefficient of Variation, percentage, etc.*

*The fourth chapter **"Material Productivity"** attempts to highlights the measurement of material productivity, material control and improvement techniques. It also elaborates the steps in measurement of material productivity. First step in material productivity measurement is revaluation of material input at base year prices of all the sampled companies. Second step is computation and analysis of material productivity ratios and material productivity indices and then testing the hypotheses for all the companies. Lastly, the possible savings have been calculated by taking minimum input output ratio as a base for the respective company to improve material productivity.*

*The fifth chapter **"Labour Productivity"** explains the ways by which labour productivity can be improved. It also explains in details the steps associated with the measurement of labour productivity. According to the steps first of all, revaluation of labour input has been calculated as per the base year price index. By keeping in mind the labour input, labour productivity and labour productivity indices have been calculated. After this the hypotheses at intra-company and inter-company levels have been tested and results have been drawn and analysed. Possible savings have also been calculated to provide suggestions to the sample companies. At the end inter-company average comparison has been made for the different sectors.*

*The sixth chapter focuses on **"Overhead Productivity"**. Overhead has broadly been classified as power and fuel, depreciation and amortisation, repairs and maintenance and lastly business service input. Business service input includes the other overhead expenses which are not able to classify in the specified overhead heading. After the computation of overhead productivity ratios and indices, hypotheses have been tested and analysed. Possible savings and comparative average overhead productivity have also been described.*

*The seventh chapter **"Overall Productivity"** combines all the elements of input and overall productivity has been calculated. This chapter also explains the concept of investor input and also the method of calculating investor input with the help of average investment. By considering the investor input element overall*

productivity has been calculated, hypotheses have been tested and analysed. The comparative average overall productivity among all sampled companies has also been calculated.

The last chapter ***"Summary of Findings and Suggestions"*** *contains the summary of all the chapters taken together along with some policy recommendations to the companies. Here some limitations of the study and the further scope for the future research have also been explained in this chapter.*

(Priya Taparia)

CANDIDATE'S DECLARATION

I hereby, declare that the work, which is being presented in the thesis, entitled "**PRODUCTIVITY ACCOUNTING IN SELECTED NIFTY 50 COMPANIES**" in partial fulfillment of the requirement for the award of the Degree of Doctor of Philosophy, carried under the supervision of **Dr. Meenu Maheshwari** and submitted to the University of Kota, Kota represents my ideas in my own words and where other ideas or words have been included, I have adequately cited and referenced the original sources. The work presented in this thesis has not been submitted elsewhere for the award of any other degree or diploma from any Institution.

I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will cause for disciplinary action by the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Date: **Priya Taparia**

Place:

This is to certify that the above statements made by **Priya Taparia** (Regd. No. RS/30/16) are correct to the best of my knowledge.

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"At times, our own light goes out and is rekindled by a spark from another person. Each of us has cause to think with deep gratitude of those who have lighted the flame within us." – Albert Schweitzer

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(Priya Taparia)

INDEX

LIST OF TABLES

LIST OF ABBREVIATIONS

ILO	International Labour Organisation
NPC	National Productivity Council
PAM	Productivity Accounting Model
QWL	Quality of Work Life
QC	Quality Circles
RME	Raw Material Equivalents
IOT	Input Output Table
DEFRA	Department for Environment, Food and Rural Affairs
ANOVA	Analysis of Variance
CEE	Central and Eastern Europe
TFP	Total Factor Productivity
BEEPS	Business Environment and Enterprise Survey
ICT	Information and Communication Technology
CDM	Crepon Duguet Mairesse
GDP	Gross Domestic Product
MFP	Multifactor Productivity
GCI	Global Competitiveness Index
CPM	Critical Path Method
RFNL	Rite Food Nigeria Ltd.
OLS	Ordinary Least square
CSR	Corporate Social Responsibility
DEA	Data Envelopment Analysis
MCE	Multiple – Criteria Evaluation

MBO	Management by Objective
SMART	Specific measurable attainable, realistic and time bound
OECD	Organisation for Economic Cooperation and Development
TDABC	Time Driven Activity Based Costing
HMT	Hindustan Machine Tools
CIMMO	Central India Machinery Manufacturing Company
JMEL	Jaipur Metals and Electricals Ltd
IL	Instrumentation Ltd.
NVA	Net Value Added
StCBs	State Cooperative Banks
NSE	National Stock Exchange
CV	Calculated Value
TV	Table Value
APA	American Psychological Association
EOQ	Economic Order Quantity
CIMA	Chartered Institute of Management Accountants
BPR	Business Process Reengineering

Chapter-1

Introduction

CHAPTER 1

INTRODUCTION

1.1. Introduction

At the times of crisis, the management needs to reconsider their traditional methodologies to carry out their functions. The managers came across, the different situations and the way they react to the given situation determines their success. Hence, productivity has been a continuous and significant issue to look after even in the contemporary times.

As quoted by Stainer (2018), in the words of Mahatma Gandhi, "Productivity is about making the most of time and talent, and hence, energizing the whole surrounding environment." This signifies that productivity is all about the measurement of resources bought and utilised in order to achieve a set target effectively and efficiently.

According to Meyer, P. J., "Productivity is never an accident. It is always the result of a commitment to excellence, intelligent planning and focused effort." This indicates that the productivity will never go on its own, it can be achieved by the hard work of workers of an organisation.

The economic as well as the social development of a country mainly depends on the efforts of productivity improvements. The productivity is not only necessary for enhancing the growth and development of an under developed country but it is equally required for a developed country. Productivity speeds up the process of quality production which further results in equal development.

The concepts used in this chapter are based on the papers published by us in different journals (Reference No. 15 to 21).

1.2. Meaning

The term "**Productivity**" refers to the optimum use of productive resources in an organisation or the optimization of resources. It is one's ability to produce more as compared to the input incurred. Productivity means the results produced of output to a single input or an aggregate input used in a given condition.

The term Productivity and Efficiency seems synonyms. But there is a slight difference between the two. The productivity of an organisation may be indicated without any improvement in its efficiency. On the other hand, the efficiency of an input may increase without any simultaneous improvement in its productivity. By differentiating the words productivity and efficiency one is actually differentiating between quantity and quality. If one is obtaining more output than inputs results in productivity but by utilizing the optimum resources/ inputs one is actually obtaining more output is termed as efficiency.

In general, productivity is a ratio of output to input, this ratio shows the actual performance of a business concern. It is concerned with efficiency and effectiveness. Productivity is the real index of efficiency of an organisation. As efficiency should get reflected in productivity measures, productivity is considered to be a good proxy for efficiency. Productivity is the relationship between output, physical or monetary, and one or more of the inputs measured in monetary terms or in the physical form used in the production process. It is expressed as a ratio to reflect how efficiently resources have been used in creating outputs.

1.3. Definitions of Productivity

During the initial years, per worker production capacity is considered as the productivity. But in yester years, various authors have defined productivity in different ways. Some of them are being stated below which have been summarized from the studies of Agarwal & Goel (2017-18), Gupta (1989) and Chunawalla & Patel (2007), Mangat (2018) and various other studies.

According to Lal, B. B., "Productivity as a measurable relationship between well-defined outputs and inputs, i.e., between the production results and the relative production agents in both the financial and physical terms in relation to given terms and conditions."

According to Gupta, C. B., "Productivity refers to the physical relationship between the quantity produced (Output) and quantity of resources used in the

course of production (Input). It is the ratio between the output of goods and services and the inputs of resources consumed in the process of production"

Taper, L. stated that "In the background of productivity the good wish of the managers is involved that the three basis of industry- man, machine and materials- are used fully and efficiently."

Menon, V. K. R. described that "The productivity means to workout a simple, economic, best and dynamic medium to manufacture any product, to provide a service or to do a work."

According to businessdictionary.com, "Productivity is a measure of the efficiency of a person, machine, factory, system, etc., in converting inputs into useful outputs. Productivity is computed by dividing average output per period by the total costs incurred or resources (capital, energy, material, personnel) consumed in that period. Productivity is a critical determinant of cost efficiency."

According to Oxford Illustrated Dictionary, productivity is defined as, "Efficiency in industrial production" to be measured by some relationship of outputs and inputs.

In 1979, National Research Council stated "Productivity is the relationship between output produced and one or more of associated inputs used in the production process."

Baig (2002) has defined productivity in the following words, "Doing things right at the least possible cost in least possible time with the highest possible quality and to the maximum level of satisfaction of the customers and employees."

Baig (2002) again writes that, "Productivity has different meaning to different people. According to him, for employers productivity means improve in the competitive position in the market, for employees, it is increase in compensation, development of skills and other capabilities, for customers it is lower price, high quality timely delivery, for society, it is low inflation, improvement in living standards, environmental protection and lastly for government productivity is increase in the revenues, more resources for social services."

Various authors have defined productivity, however International Labour Organisation has defined Productivity in fair sense i.e. "the basic principle of productivity is to make the best use of limited factors of product, like- land, capital, labour, raw material and management etc. so that maximum production becomes possible on to minimum economic and social costs."

1.4. Evolution of Productivity Movement in India

Chunawalla and Patel (2007) and literature available from the website of National Productivity Council of India throw the light on evaluation of productivity movement in India.

After the independence of India, government is more concerned to improve productivity in respect of all aspects. Thus in 1952 and 1954, government of India invited the team of experts of International Labour Organisation (ILO) in order to establish a council or a body in the country which will keep an eye on the productivity. In 1957, Government of India appointed a committee on productivity which visited Japan to study the constitution, administration and working of the productivity center in Japan. Later in 1958, on the recommendations of the committee, National Productivity Council came into force whose main objectives were:

- To promote the productivity awareness in respect of all the sectors of Indian economy.
- To spread the knowledge of the concepts, techniques, methodology adopted for productivity improvement.
- To demonstrate their value and validity in the practical application.

The headquarters of National Productivity Council (NPC) is situated at New Delhi. Local productivity councils have also been established to monitor the productivity at local levels. The main activities of NPC are being summarized below:

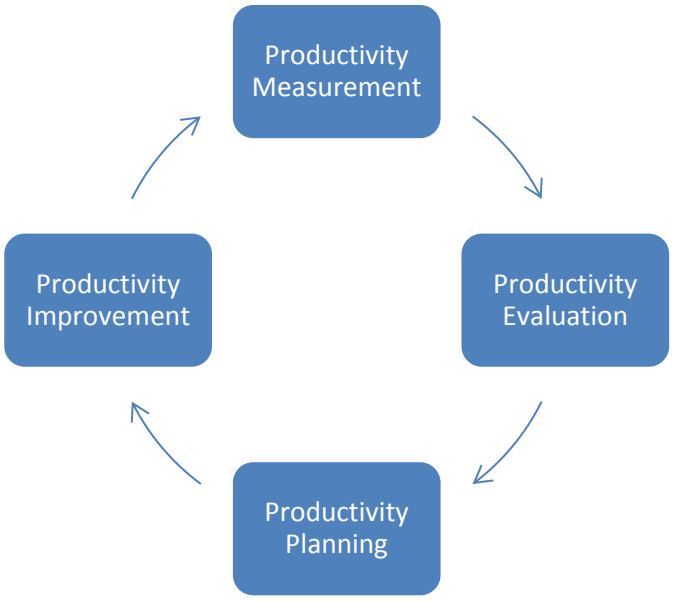
- It helps in establishing and developing local productivity councils and guides them in performing its activities.

- It organizes training programs directly or through local productivity councils to train the persons in relation to productivity enhancement.
- It organizes national and regional seminars and conferences for promoting productivity activities in India.
- It conducts productivity surveys in different units and areas of management.
- It broadcasts the various information and data in the form of various publications that crates awareness about productivity.
  - Productivity Journal (Quarterly)
  - Productivity E-Newsletter
  - Training Report
  - Annual Productivity Report
- It maintains libraries at headquarters, regional directorates and at local productivity councils.

1.5. Productivity Cycle

According to Murthy (2007), an organisation has to follow the productivity cycle in order to successful improvement in the productivity. The productivity cycle includes:

- Productivity Measurement
- Productivity Evaluation
- Productivity Planning
- Productivity Improvement



An organisation which wants to start the productivity programme can start it with the measurement of productivity of the existing resources used. Once the productivity is measured then it is evaluated or compared to the planned targets. On the basis of this evaluation, planning related to productivity targets is being formulated on short term as well as long term basis. In accordance to the planned targets, productivity improvement takes place in an organized way. To assess the level of improvement, productivity is measured again. Thus, this cycle continues as long as the productivity programme operates in the organisation.

1.6. Importance of Productivity

An organisation can be benefitted from the opportunities being offered by the contemporary world that can assist in enhancement of its productivity. Productivity has become not only a necessity for the development of the organisation but also for the survival in the competitive world. As stated by Jain, Narang & Agrawal (2013), according to the Former Prime Minister of India late **Lal Bahadur Shastri**, "Higher productivity means more efficient use of all types of resources in employment, using them to produce as many goods and services as possible, of the kind and quality most wanted by consumers, at lower and lower cost. It is in essence, a multipronged, mass attack on waste on the one hand and optimum use of all instruments and tools of production on the other."

Hence, its importance can be explained in the following points which have been summarised from the studies of Aswathappa & Bhat (2010), Jain, Agarwal & Garg (2018-19) and many others related to the topic.

1.6.1. Basis of Economic Development

If the economy is highly productive then it means that with the same amount of resources one is able to produce more goods or services or with fewer amounts of resources one is able to produce the same level of goods or services. Any plan of economic development should include the productivity increase programmes.

1.6.2. Affects Every Sector

Productivity affects each and every sector of the economy. Some of these are being explained below:

- **Government :-**

  Higher tax revenues are the results of increased productivity. Through productivity government can set up an accountability framework for using of scarce resources.

- **Businesses :-**

  Increased productivity may results in higher business profit and increased opportunity for investments. It also forces the business, to search for the unutilized opportunities in the business.

- **Workers :-**

  Higher productivity leads to higher wages and salaries and also increases better working conditions for employees creating a sense of satisfaction towards organisation.

- **Society :-**

  Increased productivity leads to job creation as a result of it increases employment which raises the standard of living of the persons in society.

- **Shareholders :-**

  Increased profits and dividend distribution are results of increased productivity which leads to creation of wealth to its shareholders of products.

- **Customers :-**

  It benefits customers through lower prices of products as optimum utilisation of resources is made.

- **Environment :-**

  Productivity benefits environment by adopting more stringent environment protection plans. Exploitation of resources can be avoided as optimum use of resources is ensured.

1.6.3. Edge over the Foreign Competition

India is a developing nation and it will take time to achieve the "DEVELOPED NATION" title. Productivity increases the production with an increase in quality and decrease in costs. As a result it helps manufacturers to face foreign competition and to get an edge over the competition.

1.6.4. Important in Scientific Management and Rationalisation

Productivity is the main feature of scientific management and rationalization process. Modern industrial setup will be nothing but dead-iron-boxes if scientific management & rationalization principles are not applied.

1.6.5. Raises the Living Standard of Society

Productivity facilitates in qualitative production and decreases costs, providing economic and good quality products to customers as a result raising the living standard of the society as a whole.

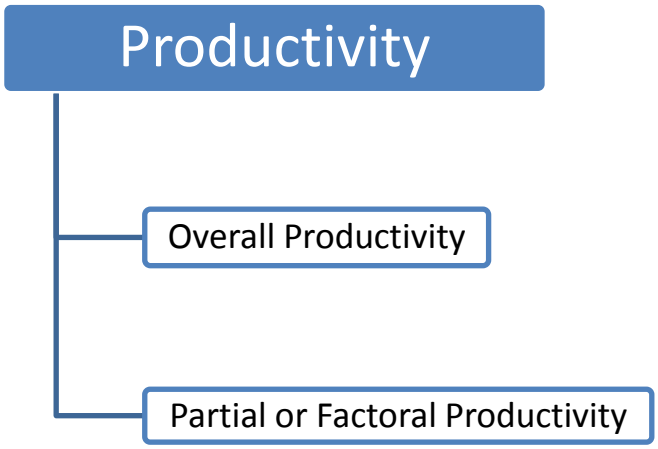
Productivity measures are also useful in the following management functions:

1. Productivity measurement is helpful in setting the goal of an organisation.
2. With the help of productivity measurement one can estimate the resource requirement in an organisation and also resources are reallocated according to the requirement.
3. Cost reduction may be possible according to the productivity.
4. It is also helpful in the responsibility accounting.
5. It results in the motivation among employees for improvement.

1.7. Overall Productivity and Partial or Factoral Productivity

Manonmani (2012), Reddy & Naidu (2013), Saxena & Vashist (1997) are of the views that, Productivity of a concern can be measured as follows:

1. Overall Productivity
2. Partial or Factoral Productivity



1.7.1. Overall Productivity: Overall productivity is the total of all productivity taken together and adjusted to price fluctuation or when the total output of an organisation is compared with all the inputs taken together is termed as overall productivity. Overall productivity can be measured by applying the following formula.

$$\text{Overall Productivity} = \frac{\text{Total Output}}{\text{Total Input}}$$

$$= \frac{O}{M + L + Oh + C}$$

Where,

O	=	Total Output
M	=	Material Input
L	=	Labour Input
Oh	=	Overhead Input
C	=	Capital Input

1.7.2. Partial or Factoral Productivity: Partial productivity can be calculated by taking anyone of the following factors.

- **Material Productivity**: Material productivity means ratio between output and material input only. Material input includes material as well as all other elements directly associated.
- **Labour Productivity**: Labour productivity is computed by dividing the output by the labour cost incurred by the organisation.
- **Overhead Productivity:** Overheads are the residual expenses incurred by the organisation. Its productivity is calculated as a ratio of outputs to the overhead inputs.
- **Productivity of Capital Input**: Capital input means the capital invested by the company in the business. Its productivity is calculated to ensure the optimum utilisation of the funds of the company.

1.8. Productivity and Production

Productivity and production are the connected terms used in the commercial environment but productivity is not production. The efficiency of an organisation in the production can be called as the firm's productivity.

Productivity is a measure of how efficiently resources are combined and utilised in the organisation for achieving the desired goals. It is expressed in relative terms. It represents the ratio of output to input. Productivity determines the efficiency of factors of production.

Production is the function of an organisation which is associated with the conversion of range of inputs into desired outputs. It is expressed in absolute terms and usually represents the number of units actually produced.

Saxena and Vashist explained that "there are chances when production may increase but productivity may remain constant and there are cases when productivity increases with the increase in production." This can be explained with an example which is as follows:

For example, a person produces 2 kg. of output from 20 kg. of input. Afterwards he starts producing 4 kg. of output from 40 kg. of input. In this case there is an increase in production but the productivity that is the ratio of output to input remains the same. Afterwards, the person changed the technique for obtaining output which results in the production of 3 kg. of output from 20 kg. of input and additionally saving the time and energy. In this case productivity of the person is increasing with the increase in production. Suppose he produces 2 kg. of output in 15 kg. of input, here its productivity is increasing but with same level of production.

1.9. Productivity and Profitability

Both productivity and profitability are considered as the key in the success of a business as it is very difficult to have one without the other.

Productivity is defined as the relationship between the output and input required to create a product while profitability is the concept derived from the word profit.

Profitability is the financial measure for measuring the performance of an organisation. It is the money left over after meeting the expenses related to the production of a product.

As per Saxena and Vashist, "Improvement in profitability may not necessarily result from improved productivity." For example, the waiver of any duty by the government may result in profitability but it doesn't mean an improvement in productivity. In the same way, there are many organisations which have no or very less profit but they utilises their resources optimally thus generating productivity.

1.10. Purposes of Productivity Analysis

Jain, Agarwal and Garg (2018-19) opine about the purposes of productivity analysis.

1.10.1. Comparing an Enterprise with its Competitors

An enterprise can be compared by its competitors on the basis of its productivity generation. Enterprises generating more output out of less input are considered to be more productive as compared to others.

1.10.2. Determining the Relative Performance of the Department and Workers

Performance of the different departments in an organisation can also be measured by evaluating the productivity of the departments and comparison may be possible among them. It is also helpful in remunerating a more productive worker on the edge of others.

1.10.3. Comparing Relative Benefits of Various Types of Inputs for Collective Bargaining and Gains Sharing

It is due to productivity, benefits of various types of input are determined and according to that collective bargaining, negotiation can be possible between the labour unions and corporate employers and gains are shared accordingly.

1.11. Approaches for Measuring Productivity

Simpson, H. (2009) mentions the different approaches for measuring the productivity which are being explained as below:

1. Index Number Approach

This is the one of commonly used technique for measuring the productivity of a concern. Laspeyres output quantity index (Q_O) and Laspeyres input quantity index (Q_I) is used for measuring productivity growth if the data are available in volumes. An index measure of productivity growth is measured by the following formula.

$$\text{Productivity} = \frac{Q_O}{Q_I}$$

If data are not available on quantities that means data are available on revenues, input costs and prices then productivity indices can be constructed by deflating the revenues and costs by the relevant price indices.

2. **Parametric Estimation Approach**

An alternative method to index number technique is parametric estimation, estimating a production and cost function. Here, instead of directly using information on the share of each factor to calculate an index, the factor share of each input is a parameter which is to be estimated and productivity is measured. Productivity can also be estimated via a cost function, where costs are expressed as a function of different outputs and the prices of each of the inputs. By assuming cost minimization a cost function can be estimated together with the input factor.

3. Non-parametric Approach

This approach measures the efficiency of a particular concern by its distance from the 'outer envelope' of the data. This outer envelope is assumed to measure the combination of outputs that a fully efficient organization could deliver for a given set of inputs, and all deviations from the frontier are classified as inefficiency. The main focus of this approach for the measurement of productivity is that it does not require information on weights to aggregate outputs (or inputs), and hence does not require information on prices. It essentially allows the data to determine the

weights (subject to any restrictions placed on the weights by the researcher) so that an organization's productivity is presented in the best possible light. Since the technique relies on the use of extreme observations (i.e. the maximum amount of a particular output) in determining the position of the frontier and the individual efficiency scores, it is very sensitive to incorrect measurement in the data.

4. Partial Efficiency Measure Approach

Productivity related to individual outputs or services can also be measured by using partial efficiency measures approach. Measuring productivity for a single output clearly gets around the problem of specifying weights to aggregate outputs together, but may in turn create difficulties in terms of isolating the precise inputs used to deliver that particular output. Hence, there may be a tradeoff between using an accurate measure of a particular output or outcome and a precise measure of inputs. Partial efficiency measures may be relatively easy to interpret and monitor which suggests they may provide useful indicators of performance. But because they are only partial they may have drawbacks if used in regulation or as a tool in performance evaluation. They will not capture all the outputs delivered by an organization, and constructing an overall indicator of an organization's productivity may prove difficult if it scores highly on some partial measures but poorly on others.

5. Some Other Approaches

Some other productivity measurement approaches are as follows:

- **Kendrick Approach**

This approach is based on the two input factors only – labour and capital. Productivity has been denoted as ratio of output and the sum of combined weighted inputs of labour and capital. This approach is based on the arithmetic indices.

- **Fabricant Approach**

This approach is also same as Kendrick approach. But it uses both weighted and unweighted man hours and tangible capital. This approach results in two estimates, the first is based on the unweighted to input index and the second is on the weighted total input index.

- **David T. Owyong Approach**

According to this approach total factor productivity is the weighted average productivity of all the inputs, where the share in the total cost of production is considered as the weight.

- **Beri Approach**

This approach constructed the total productivity by combining partial productivity indices such as material, fuel & power, labour and capital with the help of a weighted arithmetic average which is adopted in proportion to the value of inputs as per the base year.

1.12. Productivity Measurement Models

As Sharma (1989) and Maheshwari (1998) mention in their study, the various productivity measurement models suggested by Sardana and Vrat which are as follows:

1. **Production Function Model**

   It is based on the approach which considers production as a main function for an organisation. According to this model productivity has to be measured by the production function. This model considers only labour and capital as input. Other input variables such as material, overhead, etc. are not considered in this model.

2. **Economic Utility Model**

   According to economic utility model use of multi ratios are recommended. Here each ratio will reflect on a particular economic activity or a utility function. The ratio of output to input is not followed here. It is recommended to use this model at macro level as compared to micro level for measuring productivity.

3. **Measurement through Financial Ratios**

   Financial performance of an organisation can be analysed on the basis of the financial ratios. But sometimes financial ratios can also represent the productivity measurement. Productivity of an organisation depends largely on the stability, solvency, liquidity, activity of an organisation. Therefore areas such as stability, solvency, liquidity, profitability, turnover, etc. can be studied for measuring the productivity on an organisation. Ratios such as acid test ratio, current ratio, debtor's turnover, creditor's turnover stock turnover, return on capital employed etc. can be used for measuring the productivity. If these ratios are favourable then it indicates that the organisation is more productive. If these ratios are not favourable then the organisation is considered to be less productive.

4. **Surrogate Model**

   This model measures the productivity which is valid and is not difficult to define in terms of data collection. So, this model is considered as an approach to partial productivity. The model considers only the limited factors which may affect the productivity. Thus, this model is more useful for small level organisations. The model measures the productivity with the help of payroll records.

Productivity Index = $\frac{\text{Actual Pay}}{\text{Standard Pay}}$

Actual pay is the pay, paid to the worker or labour. Standard pay is the hours worked by worker or labour multiplied by the standard rate of pay.

5. Systems Approach Based Model

According to this approach measurement of productivity is reduced to measuring the output as a whole generated by a system and measuring the input considered during that system. Productivity measurement presented by this model is based on the conventional methodologies and also output and input have been calculated by keeping in mind the traditional method.

6. Production Based Model

These models have been divided into two major categories:

i) Model Based on Output as Value of Production

Kendrick and Creamer are considered to be the propounder of this approach. They suggested that there are three types of productivity indices that can measure and analyse the productivity of a company.

1. Partial Productivity Index

   $= \frac{\text{Output}}{\text{One factor of input}}$

2. Total Productivity Index

   $= \frac{\text{Total Output}}{\text{Total Input}}$

3. Total Factor Productivity Index

   $= \frac{\text{Net Output}}{\text{Total Factor Input}}$

Here,

Net Output = Output Less (-) Intermediate goods and services

Total Factor Input = Manpower input + Capital input

ii) Model Based on Output as Value Addition

The main emphasis of this model is on labour and also there are limitations inherent in this model. According to H. S. Davis, “The practice of using output

per unit of labour time expended to answer all questions about productivity performance has led to confusion." Here the value added per man hour has been taken for measuring productivity. But generally value addition is the total cost of products minus the total cost of purchases.

7. **Productivity Accounting Model (PAM)**

   According to Sardana and Vrat (1984), "The model should be such that it may help management in analyzing areas of improvement, take into account all possible outputs and inputs used, keep out external factors such as price rise etc., from the calculation of productivity of the organization and the data should be available for the measurement of productivity." All the conditions mentioned above are not satisfied in all the models discussed above due to their inherent limitations but productivity accounting model is only the model under which all the above mentioned conditions are satisfied. This model is based on accounting data, so this is called as the productivity accounting model.

   Thus, Productivity Accounting is a technique of measuring and analyzing productivity by the relation of total output to total input after both have been revalued to some appropriate scale of constant prices and it is grounded on basic accounts of a firm.

1.13. Difficulties in Productivity Measurement

Khandelwal, Gupta, Ahmed and Sharma (2019-20) and OECD (Organisation for Economic Co-operation and Development) Manual highlighted difficulties in measurement of productivity as follows:

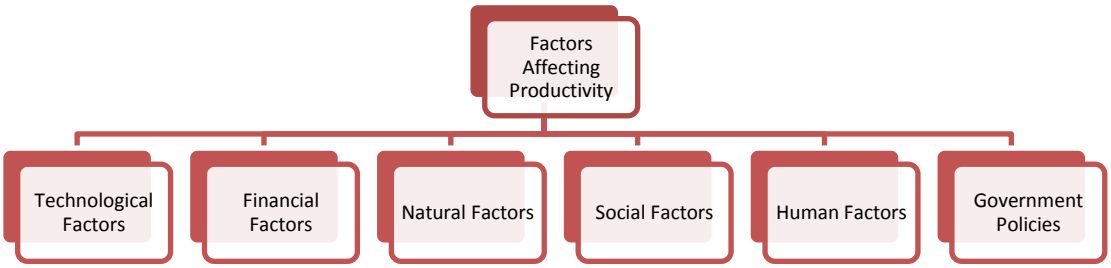
1. **Difficulty in Measuring Output:** The output of an organisation can be measured in terms of volume (units) or values (amount). If the output of all products is similar, then it can easily be measured in terms of units. If it is not similar, then also it can be measured in terms of value. But if some products are similar and some are not, then the organisation may face the difficulty in measuring productivity.

2. **Difficulty in Measuring Input:** Most of the companies do not maintain record of machine hour worked, labour hour worked, etc. Hence, productivity of them is difficult to measure.
3. **Changing Condition:** In the era of changing technology and environment, where the prices of inputs and outputs including the quality of raw material and machine tools, labour, etc. are changing continuously, creating a difficulty in measurement of productivity.
4. **Technological Change:** Due to the change in the technology, there is a change in the nature and quality of output. Thus, creating difficulty in measuring productivity.

1.14. Factors Affecting Productivity

The factors which affect the productivity of an organisation will depend on its intensity to influence organisation's day to day affairs. Once the factors are ascertained effective measures can be taken to improve productivity.

In the words of Gupta (1989), "Productivity is the outcome of several factors. These factors are so interrelated that it is difficult to identify the effect of any one factor on productivity. He has suggested these factors:



1.14.1. Technological Factors

Increase or decrease in productivity is largely affected by the technological factors. It is due to the technological factors that productivity increase has resulted in industrialisation. The process of industrialisation has gained its pace by optimally utilizing the machines and equipments, power and fuel, reduction and utilisation of waste and scrap, research and development, etc.

1.14.2. Financial Factors

Financial factors are the factors which are related to money, so more or less productivity is governed by these factors. Money is required in each and every activity in an organisation such as investigation, research, policy implementation, facilities and training to workers etc.

1.14.3. Natural Factors

Natural factors means factors such as environmental issues, atmospheric pressure, natural resources, etc. The capacity of an organisation in disposing off these factors results in the productivity enhancement otherwise it may decrease the productivity of an organisation.

1.14.4. Social Factors

Social factors also have a great impact on the productivity of industries. Social factors means factors such as social environment, expectations of the common man, social responsibilities, etc. If an industry is positively accepted by the social factors then it may results in higher productivity.

1.14.5. Human Factors

Human nature and human behaviour also play an important role in the productivity development. Human's ability is governed by education, training, experience and willingness to work. It is influenced by motivation and morale of people resulting in productivity enhancement.

1.14.6. Government Policies

Government rules and regulations also affect the productivity of an industry. Government policies promoting particular industries may result in improvements in productivity of that industry.

1.15. Productivity Improvement Techniques

According to Gupta (1989) and Institute of Cost Accountants of India (2016), there are numerous techniques developed and recommended for improving the productivity of an organisation. Some of these techniques have been elaborated and discussed below:

1. Work Study

Scientific analysis and improvement of work in all aspects is a very effective technique to improve productivity. Work study indicates improvement in material handling system of an organisation, process implementation and design, standardisation of work, improvement in working condition at work place, improvement in overall plant layout, etc. These factors ultimately results in decrease in waste and increase in the quality and quantity of work.

2. Research and Development

Continuing and ongoing research and development process results in better and innovative techniques of production, distribution, marketing system in an organisation. It also results in improvement in existing system of an organisation. The rate of technological progress is a direct determinant of productivity. That is why a large number of companies spend a huge sum of money and time on research and development activities.

3. Incentive Schemes

Incentives schemes are developed to motivate employees by paying extra monetary remuneration in terms of incentives. An organisation can also motivate its employees by sharing profits with them, declaring bonus, employee's welfare activities and favourable working conditions. All these schemes inculcate a sense of belongingness among employees and a closer human relationship. Due to this idle time caused by absenteeism, labour turnover, accidents and disputes can be reduced to minimum.

4. Production Planning and Control

Effective and productive planning may result in timely supply of inputs, proper maintenance of plant, efficient work, proper scheduling and regulation of day to day activities of plant. It results in full utilisation of plant capacity, achievement of production target and ultimately the organisation target.

5. Workers Participation in Management

This is also regarded as an effective tool for improving productivity. Workers participation in management function helps in developing mutual understanding,

cooperation between the workers and the management. Workers can participate in the management in the form of joint consultation, suggestion schemes, two way communication, grievance procedure, etc.

6. Automation

Mechanisation, automation and rationalization are considered to be the important elements for improving productivity in this modern world. These schemes are more effective if the productivity gains are equitably shared with the workers as well. Such measures result in the increase in the speed and accuracy of work.

7. Management by Objectives

It is also known as management by results. In this approach individuals are integrated with the organisation. A link is created between the organizational goals and individual's target so that each and every employee is able to know how his individual work contributes to the goals of the organisation. Employee participation in goal setting, actions implementation and in reviewing performance provides a good measure of self control by an individual. As a result of it there is an improvement in the understanding, motivation and morale of the individual.

8. Job Enrichment

To enlarge the scope of the work and to give the workers more work to do, redesigning of a job is performed and this is known as job enrichment. The main purpose of job enrichment is to improve job satisfaction, motivation and morale of workers.

The following methods can be adopted for job enrichment:

1) Give workers new and more varied tasks to perform.

2) Provide greater freedom and self control in performing jobs.

3) Give opportunity to do the whole task rather than an element of it.

4) Give employees greater responsibility for their own work.

5) Provide an opportunity to the worker to become an expert in a particular task.

6) Supply production reports (feedback) directly to workers.

Diverse tasks and responsibilities result in greater flexibility in work assignments. This approach provides an experience that enriches the skill, knowledge and confidence of employees which contribute towards development of positive

attitude and positive work environment by reducing absenteeism, turnover and idle time among the employees.

9. Flexi time

This is a modern concept which allows the workers to decide their own working hours subject to a minimum number of hours per week. They are free to work anytime in which they are comfortable in the week. But during a particular period all workers are required to be present compulsorily. Such a period is known as 'core hours'. It results in reducing workers agitation and raises productivity. It reduces the continuous monitoring of supervisors as work is done by the workers as per their convenience. It also creates job opportunity to the working mother, aged person and students. It has greater motivational value than the 5 days working week. By applying flexi time technique, an organisation can reduce labour turnover, absenteeism, etc.

10. Quality of Work Life (QWL)

It is also regarded as a modern technique for improving productivity and quality of work. QWL programme consists of the following elements:

i) Workers – Management Cooperation

ii) Collective Bargaining

iii) Participative Management

Proper training should be provided to workers and supervisors for the successfulness of QWL programme. QWL requires a fundamental change in attitude and thinking of the workers as well as of supervisors.

There are many problems in its successful implementation. Some of these are being explained below:

i) Supervisors do not easily accept workers participation in the decision making process. They perceive of QWL as a threat to their power and prestige which they build up after long years of their hard work.

ii) Top management may not be willing to establish a realistic long term goals for the QWL programme.

iii) Workers and trade unions oppose the programme if it is used only for the generation of productivity.

11. Quality Circles (QC)

A quality circle is a small group of workers who meet on a regular interval with the aim to discuss problems, investigate causes, recommend solutions and if authorized by the top management to take corrective action and follow up steps. QC usually consists of 5 to 15 members who collectively perform the following functions:

i) Identify the problem
ii) Discuss the problem
iii) Analyse its causes
iv) Develop a solution to resolve the problem
v) Present the solution in front of management
vi) Implement the solution if authorised by the management
vii) Take follow up steps

One person named as Leader is appointed to direct and guide the circle. A Facilitator makes integration of programme easier at all levels and the Coordinator supervises the facilitators and directs administration of the programme. A steering committee is created which oversees and directs the efforts of all quality circles in an organisation.

1.16. Concluding Observations

Productivity of an economy largely depends on the growth and development of the companies in that economy. So, it is very important for a company to be productive by enhancing the quality production and results in even development of the economy of the country. This chapter highlights the meaning, definitions of productivity given by various authors. It also explains the evolution of productivity in India with its importance. This chapter further highlights the difference between the partial and overall productivity concepts. It also explains the difference between the productivity, production and profitability. Various models related to productivity measurement have also been explained along with the various techniques of measurement and productivity improvement.

Next chapter will explain the reviews of national level and international level literature which help in finding out the research gap that results in the establishment of the objectives of the research.

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Chapter-2

Review of Literature

CHAPTER 2

REVIEW OF LITERATURE

2.1. Introduction

Review of literature is the fruitful outcome as the summary of studies related to a particular area of research. The literature available for review refers to the previous researches on a particular topic and the review represents the explanations of what the literature puts for future.

The main objectives behind the review of literature are as follows:

1. It surveys the literature on the area chosen for the research.
2. It critically analyses the information gathered by identifying the gaps in the present research.
3. It is also considered as a base for the further research.

As per the topic of research "Productivity Accounting in Selected Nifty 50 Companies" an attempt has been made to study the different available literature in this particular field to assess and analyse the performance and productivity of Nifty 50 companies. This chapter presents chronological review of literature which has been divided into two sections according to the level of literature:

1. Reviews of International Level Literature
2. Reviews of National Level Literature

The reviews in this chapter are based on the research papers published by us in various journals (Reference No. 39 to 45, 60).

2.2. Reviews of International Level Literature

Islam (1990) focused on the measurement and analysis of labour productivity with distinct reference to cotton textile industry in Bangladesh. The study is focused on 13 mills categorised on the basis of their year of establishment. The three categories have been developed viz., category A (1951- 1960) includes three mills, category B (1961-1970) includes seven mills and category C (1971-1980) includes three mills. The evaluation has been carried out at two-stages. The labour

productivity has been elucidated comprehensively while the differential labour productivity has been analysed at inter-firm level. The analysis of the study attempts to grab all these aspects it measures output in physical terms and labour input in actual hours worked in approaching plant level investigation of labour productivity. This evaluation includes cross-sectional data and various hypothesis tests regarding factors affecting labour productivity. This study considers a production worker only as a labour input.

Dias (1991) stated that the role of manufacturing industries as an essential part of Sri Lanka's development programs hence it has been regarded as a significant component of the internal growth strategy of an organisation. Productivity enhancement results in increase in standard of living conditions. The study examines the regional variations in labour and capital productivity of manufacturing industries in Sri Lanka. It recognised the existence of substantial regional differences among these levels of productivity. The results further stipulated that the regression outcomes from the study shows that spatial disparity of labour productivity is positively related to capital intensity and the level of urbanization and is negatively associated to the nature of enterprise. The investigation also stipulated that there is a considerable scope for increasing production in some districts in Sri Lanka.

Brynjolfsson (1993) explained the reviews related to the relationship between information technology and productivity. The increased interest in the productivity paradox has been vanishing a noteworthy amount of research, but this has only strengthened the mystery. The author tried to answer the questions regarding what one should know and what one should not know, differentiated the central issues from diversions and clarifies them to be used in further research. The question about researches econometric evaluates and also indicates low IT capital productivity in a variety of manufacturing and service industries. It has been observed that research on information technology and productivity has been in poor position. The author postulates that the information technology has positioned the industry for greater growth in the future.

Bjurek (1996) analysed in his study the Malmquist Total Factor Productivity Index. The definition of the Malmquist output and input quantity indexes designate by Caves et al. (1982) has been applied in the present study. The definition perpetuates the fundamental attributes of a productivity index as a ratio between an output and input quantity change index. The Malmquist productivity has enhanced the standard approach in productivity measurement over time especially when non parametric enumeration applied to micro data. While elucidating the Malmquist productivity index the author argued that there are two natural approaches for computation of productivity differences. One approach treats productivity differences as differences in maximum output provisional on a given level of inputs. This approach leads to output based productivity indexes. The alternative approach serves productivity differences as differences in minimum input requirements provisory on a given level of outputs. This views leads to input based productivity indexes. This paper provides an exploration of the belonging of a Malmquist Total Factor Productivity Index. This productivity index has become the standard approach in productivity computation, especially when non-parametric specifications are applied. Moreover, the Malmquist input and output quantity indexes furnish dominant information that can be used to explain the aspects of productivity changes caused by underlying economic decisions and activities.

Bai and Li (2004) examined the convergence process of industrial productivity in Chinese region. Both standard deviation and beta convergence has been employed using a panel of data over the period 1985-1999. Regional productivity is showing the significant implication for the government in policy making at both national and regional levels. Although appreciable efforts has been made in testing income convergence across the Chinese regions. The study has also been analysed the output productivity performance of Chinese regions which are based on convergence concepts. Also, human capital has been found to be a core factor in the elimination of productivity divergence between diverse regions of China. It has been suggested that the government has to play an active role in promoting these regions and should give incentives to international firms to invest in these regions. Other potentially supremacy factor such as international trade and

investment may also be taken in production function in order to enhance the goodness-of-fit further.

Peslak (2004) aimed to find out information technology with a new data set from a European published sources and measure productivity using both market and financial based measures. The study also shows a noticeable examination issue due to the sheer size to IT spending in the economy as a whole and its anticipated positive collision on firm level productivity. The analysis of the productivity impact of IT on organisation has been gradually slow. The inclusive purpose of this study was to dictate whether a Productivity Paradox exists at the firm level for European units. The conclusion of analysis found a positive relationship between IT spending and firm level productivity in European units. The analysis also put impact of IT spending in current time frame, international analysis, using both financial and market based measures.

Schoer (2006) in his paper, "Calculation of direct and indirect material inputs by type of raw material and economics activities" presented a technique for calculation of the direct material input used in Raw Material Equivalents (RME). It has been calculated according to the type of raw material and economic activities. Indirect raw material input had also been included in calculating Raw Material Equivalents. A technique known as Hybrid Input Output Table (IOT) had been developed for calculating the indirect raw material inputs. As per the study, RME can be considered as a suitable indicator to estimate the environmental pressure and to discharge the global responsibility. This is only possible due to the comprehensive and detailed recording of material inputs.

Gilanyi (2007) examined whether an increase in the overall productivity of an economy results in an increase in production. The comparison between Standard Economic Model and Ayres- Martina's Model has been drawn and an analysis has been done on its grounds. The study found that the standard economic perception that is an increase in overall productivity results in an increase in production holds good for short run only. Increased productivity may not necessarily results in increase in production in a long run. This is due to the reason that all economic decisions depends on the evaluation of stocks by agents and brokers.

Inklaar and Timmer (2008) argued that the standard and traditional approach for measuring output and calculating productivity has been an obsolete in the present competitive world. The lack of accounting reason of changes in prices of goods purchased for resale has been the core reason for the obsolescence. This paper has outlined a consistent accounting framework for measuring trade productivity and providing new estimates that take into account the purchase price of goods sold in a double deflation effect. The study has concluded that UK and US better productivity improvement than France, Germany and Netherland, since the mid 1990's.

Webber, Curry and Plumbridge (2009) explained the rural business productivity and rural area productivity in England. Rural area productivity means the role played in informing rural social welfare and policies for social well-being while rural business productivity is more concerned with the performance of the firm. Both these elements are important for the development of rural areas. The paper extends a factual analysis of labour productivity differentials across the DEFRA. It is the new department for environment, food and rural affairs. The objective of DEFRA is to measure differing economic performance between rural areas and enhance the performance of the weakest. The study is based on the data obtained from the survey in 2004 of larger rural firms with less than 250 employees. Making use of plant level data, the study examines the presence and differences between rural and urban productivity. Rural area productivity indicates critical significance informing rural area social welfare and polices for social well-being.

Simpson (2009) in his paper explored the issues arising in measurement of productivity in services provided by public sector organisations. There are many limitations arising in measuring productivity of public services because mainly public services are unpriced and some public services are consumed collectively. The private sector generally does not face such limitations. The significant problem arises in measuring the output and the quality improvement services delivered by public sector organisations that are valuable for the society. While measuring the productivity of public services, society may prefer the public sector

to deliver more services or refinement in the quality of services even at the expense of a decrease in productivity. The paper further explored the various techniques for measuring productivity such as index number approach, parametric estimation, etc. It further undertakes that the competition and performance incentives are regarded as the base for productivity and differences in production across organisations.

Degasperi and Fredholm (2010) examined in their paper a method of productivity accounting based on production prices. The foremost aim of this paper is to initiate an alternative method of productivity evaluation using input-output tables and production prices. This paper has also shown that how a productivity accounting can be achieved without using an aggregate production function. It has also described an alternative way of productivity accounting based on work of Von Neumann, Heontief and Sraffa on production system. The indices of labour productivity and technological progress have been constructed by utilizing the areas under the net national product and wage profit curves respectively. This method is applied by the USA, Germany, France and U.K. The study analysed that the path of the technological progress and the growth rates in labour productivity has the significant difference between the USA and U.K. and also France and Germany.

Chalermthanakom and Ueta (2011) explained the impact of environmental regulation on productivity in industries of Japan. They calculated the productivity growth by using data envelopment survey, regression analysis and using panel data on productivity growth by environmental regulation stringency. The paper also used the data from automobiles, food, electronic industries in Japan from 2003 to 2009. It has been found that there is no positive or negative impact of environmental regulation on traditional or environmental productivity while for automobile industries different results from the two productivity indices were found. Overall this study made a primary contribution to the understanding of environmental regulation and productivity growth. The study recommended that policymakers and managers should also make use of environmental productivity

in their decision making processes. In future experimentation such analysis should be undertaken with reference to greater number of industries and countries.

Ferreira and Martinez (2011) focused on the employees perceptions of productivity or company investments in respect of intellectual capital. The Bontis model of intellectual capital has been adopted. As per the model, intellectual capital has been categorised into three components, viz. human capital referring to knowledge and skills of the individual, structured capital comprising internal processes and information of organisation and customer relational capital which refers to the inter relationship of organisation and its stakeholders. The data were obtained from the survey conducted on 440 employees of 13 Portuguese companies. The statistical tools and techniques adopted in the study were ANOVA and regression analysis. It has been concluded by the results that the companies with higher structured capital have a lower perception of productivity while higher perception of investment in marketing and sale also have higher perception of productivity.

Dogan, Wong and Yap (2013) explored the turnover, ownership and productivity in Malaysian manufacturing sector. The study decomposed the sources of productivity change in Malaysian manufacturing sector with an explicit role given to establishment turnover. The study also raised several issues of breakdown by selected industries. The study focused to analyse whether firm's turnover by ownership has any impact on the aggregate productivity growth of that particular sector. For this the usefulness of adopting such an analytical frame work is necessary hence the study for a period from 2000 to 2005 was carried out. It has been concluded from the study that the turnover matters regardless of ownership, but the most important thing to keep in mind is attracting foreign direct investment inflows which could give a positive effect. The foreign entrants were relatively more productive than small one because they also get benefits from small economies. Medium sized domestic survivors contributed the most for boosting sector productivity. It has also been concluded that improvement in productivity should be in circular for long term survival of an industry in this fast changing and competitive conditions.

Jana and Petr (2013) in their study aims to contribute to the extension of the knowledge by recognizing possible positive and negative collision of profit-sharing on various areas that are important for the performance of a company. According to the study, the majority of studies have reported a neutral or a positive impact of profit-sharing on productivity and profitability. Another intention is to provide comprehensive, up-to-date literature review. The profit-sharing get constantly studied along with employee stock ownership. This study presented a comprehensive overview of key factors such as cooperation, efforts and productivity which are relevant for successful implementation of profit-sharing plan. This shows that profit-sharing may serve as a tool for increasing competitiveness but it can also be harmful when incorrectly implemented. The study based on the facts displaced through analysis asserted that a lot of work has been done in area of research on profit-sharing.

Rizov and Zhang (2014) explained the regional disparities and productivity in China. In order to illustrate the regional disparities in China, aggregate productivity has been categorized into three regional typologies which is based on the population density, coastal-island and rural-urban criteria. The study has also explored the productivity differentials across the categories of the typologies by decomposing regional productivity level. Regional disparities in China have been widely studied in recent years both in concept of economic magnification and income inequality. This study also estimates total factor productivity using micro data for a large and illustrative sample of Chinese manufacturing firms over the period 2000 to 2007. The study evaluation indicates that besides density of economic activity, recent policy and structural factors importantly affect regional productivity level and growth differentials. The focus of the study is on evaluating the regional disparities in productivity of Chinese manufacturing using micro data. The study aggregates the firm's level total factor productivity by categories of three regional typologies designed to apprehend different dimension of the regional disparities in China. The indications of investigation for policy are that initiatives facilitating factor privatization and export promotion targeted regional development initiatives facilitating factor mobility have a significant role to play in further improving productivity and reducing inequality in China.

Yildirim (2015) in his paper, "Relationship among labour productivity, real wages and inflation in Turkey" examines the inter relationship of the manufacturing industry of turkey for the period from 1988 to 2012. The author applied Cointegration analysis and a Granger Causality Test and concluded that the inflation has a greater impact on the labour productivity as compared to the real wages. According to the study a feedback effect exists between labour productivity and inflation. It has also been concluded that there is an unidirectional causality from real wages to productivity, thus indicating a broken connection among productivity and wages which is may be due to less bargaining power and structural problems comprising of high unemployment, a giant tax burden on wages and the big share of the informal sector.

Shepotylo and Vakhitov (2015) analysed the liberalisation of services and productivity in manufacturing firms. The study analysed the data of 22 manufacturing industries and 15 subsectors for a period from 2001 to 2007 of the firms of Ukraine. It has been concluded from the analysis that there is a positive effect of liberalisation of services on the productivity of manufacturing firms. The firm level services intensity to find out the variation of services intensity within an industry as compared to across industry has also been computed in the study. Olley Pakes methodology has been used for the estimation of total factor productivity incorporating the innovations suggested by De Loecker (2011).

Fattah (2015) investigated the impact of research and development spillovers on Egypt domestic total factor productivity at the industry level. The study covers the database of the 16 countries over the period from 2003 to 2008. The regression analysis has been used to test for the presence of spillovers. The Hausman specification test has been applied to determine whether the fixed effect or the random effect model is more appropriate. The present study is concerned with the impact of research and development spillovers from various channels namely - import, export, inward FDI and outward FDI. The study has been concluded that the technology spillovers through FDI, whether inward or outward have positive significant impact on total factor productivity. It has been demonstrated that the technology spillovers through imports have a negative impact on the total factor

productivity while the export has a positive and significant impact on the productivity. Thus, the author suggested that the policy makers should ensure that the foreign competition could not able to destroy the domestic competitiveness, so that the nation would able to maintain its market share of production.

Karmarkar, Kim and Rhim (2015) According to the study all major world economies are manifesting a shift from products to services in terms of relative shore of GNP and employment. In this study, an attempt has been made to construct a model of an economy with endogenous production and utilization decision by utility maximizing individuals. It also shows that distinctive productivity changes can result in either relative growth or approach situation. Simultaneous, increase in productivity increases the average wealth as expected, but income inequality may either increase or decrease. Nevertheless in the early years of the industrial revolution in the 19th century, productivity increases drove the growth of manufacturing. Fresh studies have shown that the productivity in services is also increasing. Although the aim of the study is to explore in detail, the effect of productivity changes on sectors. The author also established compatibility order for income inequality in terms of either a ratio or a gap, to increase or decrease with productivity increase.

Mijic, Jaksic and Berber (2015) conducted a comparative study of productivity and profitability of companies of the private and public sector of selected countries of Central and Eastern Europe (CEE). The investigation has been based on the statistics of productivity and profitability from "Cranet" project. The outcome of the study indicated a statistically noteworthy difference in the level of productivity & profitability between these two sectors. In public and private sector organization competition has been attributed by market competition. Profit and success are the main goal for long term private sector business enterprise. On the other hand, public sector undertaking businesses are featured by two purposes: the provision of general public interest and achieving the commercial intention of business. The study concluded that the root of the aggregate profitability study is that there is a statistically important difference in the level of profitability between

the public and private sector. Private sector companies performed significantly better than public sector companies in terms of profitability and productivity.

Ding, Guariglia and Harris (2016) analysed the total factor productivity (TFP) and its determinants in China. Productivity has been noticed as the most vital long run driver of economic growth in both economic theory and empirical research. In this study, the authors investigated the determinants of China's productivity growth using a comprehensive firm-level data set over a period. While evaluating TFP various determinants of TFP such as ownership, export, behavior, age, political affiliation etc. have been considered. When an industry and province-level decomposition is conducted it appears that the positively contributing inter-firm resources reallocation are more eminent across industries then across provinces.

Fresenbichler and Peneder (2016) in their paper, "Innovation, competition and productivity: Firm-level evidence for Eastern Europe and Central Asia" investigated the relationship of productivity to innovation and competition. Business environment and enterprise survey (BEEPS) data were used for analyzing the results. A survey was conducted in Eastern Europe as well as in Central Asia. The study has covered the survey year 2012 for Russia and 2013 for the other countries. The monetary values are mostly from 2010 or 2011 as the last complete fiscal year and were converted from local currency units into USD. They concluded that productivity in terms of either sales or value added per employee has been positively affected by competition and innovation. Further, this study has also been analysed that firm size, exports or population density impacts productivity positively.

Gorden (2016) rendered some insights of Australia's productivity. According to study in the beginning of the 20th century multifactor productivity had gone down. Australia's income growth was supported unless recent years by strong growth in trade and investment, but the trade has been falling since 2011 and investment has also been slow down. For maintaining the modest rate of growth as in last decade, long term multi factor productivity growth has been required. More widely shifts in taste and technology had delivered quality furtherance to consumer without

increase in price corresponding to the additional input required. This created the need for measuring productivity for the GDP growth. To improve the productivity, the author suggested that consumers are empowered to promote welfare enhancing market solutions through client directed subsidies, forcing the firms to compete for clients, etc.

Eldridge and Price (2016) analysed in their study a newly available GDP by industrial statistics to decide whether it can be used to fabricate reasonable quarterly labor productivity measure at the industry level. The outcome has shown that quarterly labor-productivity data at the industry level can provide the perception that how effectively labor inputs are converted into output and provide information needed to assess changes in technology labor share, living standards and competitiveness. The study concluded that the sustained growth in labor productivity empowers an economy to produce additional goods and services without an increase in labor resources, resulting in higher standard of living. However, Quarterly labor productivity data at the industry level offer users cognizance into which industries are contributing to aggregate productivity growth, where its usefulness has been affected by the highly volatile data. (Labor has been read as labour)

Hazarika and Boukareva (2016) had analysed that the demand for air transport has been continuously increasing in UAE and also UAE has reported remarkable growth in the aviation sector. The financial performance measures of two major airlines companies of UAE viz. Emirates Airlines & Air Arabia have been compared with reference to profitability, liquidity, efficiency, employee strength and productivity. The study further examined the Etihad Airways to see if there is any noteworthy footprint on the financial performance of the airlines companies. The study is based on the financial data which have been obtained from the annual reports of the respective companies. The study covers the period from 2010 to 2014. The impact of revenue on macroeconomic factors of UAE has been tested and analysed with the help of simple regression analysis and concluded that the companies can create wealth either by increasing profit per employee or by increasing the number of employees earning such profits.

Arendt and Grabowski (2017) in their paper "Innovation, ICT and ICT - driven labour productivity in Poland" analysed that the more efforts in terms of innovative sources of productivity or the introduction of new technologies are required to increase the company's productivity. In this paper, they developed a two way model to establish the relationship between innovation, ICT (Information and Communication Technology) use and productivity. The data were collected through the survey of 1000 Polish companies in the first half of 2015. The relationship has been analysed on the basis of CDM (Crepon Duguet Mairesse) model. This model explains the logic behind transforming innovation input into innovation output and then measuring the impact of innovation output on productivity. The study has also revealed that the innovation capacity, ICT implementation and use of the companies are based on the traditional sources of innovation like R&D department. The study further proves that the utilisation of ICT become more effective only if it is accompanied by co- innovative sources of productivity.

Gu and Yan (2017) furnished a measure of effective multifactor productivity (MFP) growth for Canada, U.S., Australia and selected European countries. The paper analyses that the increase in effective MFP has been closely equated with the decline in output price and enhancement in international competitiveness. Progressively, firms and industries depend on acquired imports of goods and services to revamp their productivity and competitiveness. The factual studies on global value chain finds that goods exports often have large services contents hence for improving productivity industries can enhance the competitiveness of goods exports. This survey has shown the MFP growth for small, open economics. The paper has also focused on changes in affiances MFP growth and its relationship with changes in relative price competitiveness.

Abad and Ravelojaona (2017) explained in their study Malmquist- Luenberger productivity index and Environmental- Luenberger productivity indicator. The study was conducted on 11 French airports for a period of 2008 to 2011 and analysed the implementation of the new advanced environmental productivity index or indicators. The study recommended that an innovative advanced

environmental productivity index or indicator should inherit the basic structure of the above two index or indicator so that an advanced version of Environmental Luenberger – Hicks – Moorsteen productivity indicator may be proposed. The study has also proposed an advanced generalized dynamical distance function. This shows the degree of efficiency of an organisation in context of its technical efficiency.

Shahbazi, Salloun, Kurdve and Wiktorsson (2017) presented the recent practice of material efficiency performance indicators in the manufacturing sector area through a bottom up approach. The data were collected with the help of a case study from a seven global manufacturing companies located in Sweden through semi structured interviews of environmental coordinators, plant directors and production managers as they have a deep knowledge about the reporting requirement on environment, companies manufacturing and environmental strategies and overall companies goals. On analyzing the data it has been concluded that existing material efficiency indicators in Sweden are limited and are mainly concerned with cost or quality parameter only, environment aspects has been ignored. The limited number of measurements indicates that the material efficiency has not been considered as a central business in manufacturing companies and also it has not been working towards the reduction of waste volume and an improvement in homogeneity of generated waste.

Flachenecker (2018) analysed the casual impact of material productivity on macroeconomic competitiveness in European Unions. The interdisciplinary scholars and policy makers have concluded that increasing material productivity reduces environmental pressure and also increases the competitiveness of economics. The data set has been prepared taking into consideration 28 members states of European Union from 2000 to 2014. The study estimated the casual impact of material productivity on the six indicators, viz. GDP per capita, unemployment, wages per capita, R&D per capita, current account and GCI (Global Competitiveness Index). The results indicated a casual impact of material productivity rate on wage rate and current account rate while remaining indicators are not significantly affected. The author further suggested that through incentives

including tax breaks and financial support, policy makers can convert the gains into innovations, this ultimately improve productivity and results in best use of the material input.

Berg, Marrewijk and Tamminen (2018) investigated domestic and trading firm level data sets of Dutch firms and Finnish firms. Dutch firms' data taken over the period from 2002 to 2010 while Finnish firms data covered for a period from 2005 to 2010. The relationship between the trade status, productivity and profitability has been investigated in the present study. The predictions of two models, the Melitz Model and the Egger Kreickemerier Model have been analysed to establish the relationship between the profit margins and the trade. Three hypotheses have been developed. First hypothesis was developed to analyse whether profit margins rise as productivity rises for domestic firms. The Melitz Model supports this hypothesis while the Egger Kreickemerier Model does not support it. Second hypothesis was developed to analyse whether profit margins rise as productivity rises for trading firms. Both the model supported this hypothesis. Finally third hypothesis was developed to analyse whether profit margins are at least as high for domestic firms as of trading firms. The Melitz Model does not support it while it is supported by the Egger Kreickemerier Model. It has been recommended in the study that ways should be taken to adjust the Egger Kreickemerier Model so it fits, in order to satisfy the first hypothesis.

Martin and Minondo (2018) uses highly disaggregated data to analyse the convergence process in product level relative productivity across Spanish territory. The speed of convergence in product level productivity is faster as compared to income per capita. The study has scrutinized the convergence process in product - level productivity in Spanish provinces for a period from 1988 to 2013. The study has derived a description from an Eaton - Kortun model of trade, which provide theoretical estimate of product - level relative productivities and only demand exported data. This paper has analysed the variables that might magnify the convergence in product - level relative productivities between provinces. It also shows that speed of convergence in product - level relative productivity has been faster than GDP per capita. The study also figured out that

the shorter distances, tight social ties and similar factors endowments increase the similarity in product level relative productivity between provinces. The empirical findings also point out that measures should be taken to assist the movements of people within a country, foster knowledge flows and contribute to reduce differences in product - level relative productivity across territory.

Heil (2018) surveyed a wide range of literature and highlighted the main findings related to business productivity. According to him a number of studies have been conducted which has analysed the productivity effects of financial development. The author studied the literature and analysed the relationship of productivity with finance, insolvency regimes, transmission channels, mergers and acquisition activity, direct contribution of the financial sector, financial liberalisation, equity finance, alternative finance, business cycles, etc. The result suggested by the studies conducted by the author is that financial development has a favourable impact on productivity growth. It has also been suggested that inefficient insolvency regimes become a hurdle in the productivity growth.

Pisec and Pop (2018) have presented in their study a tool for increasing productivity of manufacturing companies. This tool is a program developed to track all the elements involved in production process and to plan accordingly on all the phases. The method used for planning the production process is the Critical Path Method (CPM) because this method determines the time duration for an activity of production to conclude. The study has suggested that by using this tracking and planning program, the organisation can check the machine workload and its idle time and can analyse its capacity, time in which goods can be delivered and plan accordingly its selling and marketing strategies. One more advantage of this program is that the data is available online as well as on real time basis.

Adetunji, Fadun, Adetunji and Oyewole (2018) examined in their study whether Corporate Social Responsibility has an influence on the organizational productivity which in return enhance the quality of service provided by Rite Food Nigeria Ltd. (RFNL). The paper analysed the importance of critical success factors of Corporate Social Responsibility to organizational productivity. The data

have been collected through questionnaire survey from the 11 staff of RFNL and from 97 customers of the firm residing in 3 states. The data of the study were analysed with the help of ordinary least square regression (OLS) method. The author concluded that the Corporate Social Responsibility is responsible for the improvement of the organizational performance of productivity. The author further opined that the involvement of an organisation in CSR activities influences the demand to improve quality of services rendered to the ultimate consumers.

Rantala, Pekkola, Rantanen and Hannula (2018) had explored in their study the changes took place in the obstacles restraining productivity improvement of Finnish small and medium sized enterprises covering the data from 1997 to 2014. According to the study, the continuous improvement in productivity is the most important aspect in the overall competitiveness of companies. But this is very common issue for companies. There are some obstacles that restrain such development work resulting in restraining productivity improvement. The study also focuses on discovering these obstacles. The study has also analysed the obstacle obtained between manufacturing and service SMEs. The study concluded that there are three significant categories relating to the obstacles restraining productivity improvement. First is shift of an obstacle from internal to external, then lack of resources to lack of knowledge and ultimately a shift from lack of employees knowledge and education to lack of supervisors knowledge and education.

Agasisti, Munda and Hippe (2019) measured the efficiency (productivity) of European education systems by combining Data Envelopment Analysis and Multiple – Criteria Evaluation. The main aim of the study was to analyse the spending of European compulsory education system and allocating the ranks to the countries based on the efficiency scores given according to the spending. An innovative methodology has also been presented that combines the two methods namely Data Envelopment Analysis (DEA) and discrete Multiple - Criteria Evaluation (MCE). A set of common variables which are associated with the higher level of efficiency in education system has been identified in both the methods. The study has also concluded that the results given by the DEA method

are more or less confirmed by the MCE method results. The authors suggested that the policy makers should ensure to raise the average educational results without leaving disadvantaged students behind.

Aminu (2019) explained the impact of MBO (Management by Objective) on employee productivity. In today's era an organization can accomplish its goal due to its clear mission and vision. MBO is a management tool where managers of organization sit with subordinate and interact with them to agree on the goals of the organization, set targets, follow the targets, monitor them and appraise it. According to the study the organisation tries to maintain the relationship between understanding the objectives by employees/managers on one side and employee productivity on other side. Adopting MBO is proved useful in many organizations. The research has found many good attributes of MBO in running organization. The study has stated that MBO leads to professionalism, transparency, fairness, objectivity, independence and responsibility. The organizations has also adopted the SMART goal approach (specific measurable attainable, realistic and time - bound) for a better future.

Aigbe, Ikpefan and Egolum (2019) aimed and analysed whether technical and skilled manpower serves as a prerequisite for enhanced productivity in the Nigerian construction industry. The study is supported by the reviews of related literature so that future scope of research can be derived. The study is based on the theory of hierarchy of motivational needs advocated by Maslow and Alderfer. A sample of 45 professionals had been selected for the purpose of study. The data have been collected from the primary as well as from secondary sources from the construction companies in Port Harcourt, Rivers State, Nigeria. Primary data has been collected through the structured questionnaire which was supported by oral interview. Secondary data have been collected from the text books, journals, internet sources, etc. The data was analysed using mean and rank order while chi-square has been used for testing the hypothesis. The findings revealed that the factors responsible for skill shortage are low wages, high cost of training, etc. which results in increase in the cost of construction and delay in project

completion. So, the study recommends technological awareness and improvement in incentives for skilled manpower to encourage them to improve productivity.

Globerson and Vitner (2019) have presented a model which aimed at measuring the productivity of a product or a service that are producing different products. Two measures which are required for calculating productivity are output and the resources. Two methodologies have been adopted for calculating the output. According to the first methodology total output has been calculated for each product taking into consideration the value of item which is in process. This can be possible by equating the partial item into an equivalent number of complete items. Second methodology states that a method has been developed to sum up all the outputs by assigning the weights to each and every product according to the level of usage of the most frequently used resources.

Baily, Bosworth and Doshi (2020) elaborated the findings of industrial productivity growth between Germany, Japan and US. As these countries are the major economies which set the productivity standards for most industries to follow. The authors compared the labour productivity and total factor productivity. Labour productivity is calculated as the real value added per hour worked and total factor productivity is real value added per unit of combined capital and labour. The study is based on the statistical data obtained from the OECD. It has been stated that industries like construction and utilities where the productivity growth has been observed extremely low or negative, suffers with the problem of regulations and lack of effective competition. The author suggested that the benchmarking industry growth rates and setting productivity levels across countries are the only way to determine the weaknesses of the country in lagging behind and to find out areas where productivity gains can be achieved.

Adiguzel and Floros (2020) attempted to provide a case study pertaining to analysis of utilization of capacity in small-sized manufacturing company by applying time-driven activity-based costing (TDABC). The study has been conducted on the basis of case study, for which time equations have been developed for the auxiliary, operations and production departments through which

the products costs have been determined. Moreover, the TDABC system has been applied to analyze the capacity utilization. It has been found that time-driven activity based costing is highly applicable in the small-sized manufacturing companies due to its labour-intensive nature. It has been stated that there is a requirement of programming coding in order to capture the entanglement of the time equations and business intelligence. Though, the system of TDABC is uniform for all the companies, there is no robust form of application exist, hence it is required to maintain the reflection of unique characteristics of each company in the application of TDABC system.

2.3. Reviews of National Level Literature

Maheshwari (1998) in her thesis sheds light on the concepts related to productivity, objectives, importance, its relation with production and profitability, concept of partial or overall productivity, productivity accounting model, etc. It also explains the material productivity, manpower productivity, overhead productivity and overall productivity in companies of engineering industries such as Hindustan Machine Tools (HMT) Ltd., Ajmer, Central India Machinery Manufacturing Company (CIMMCO) Ltd., Bharatpur, Jaipur Metals and Electricals Ltd. (JMEL), Jaipur and instrumentation Ltd. (IL), Kota. The study covers a period of six years starting from 1990-91 to 1995-96. The statistical tools and techniques used in the study are chi-square test, kruskal wallis one way analysis of variance test, standard deviation, coefficient of variation etc.

Narang, Satajia and Nayyar (2010) in their paper, "Productivity Analysis: A Case Study" discloses the relationship of various components of productivity viz., business per employee, interest per employee, interest income per employee and profit per employee. This study is based on the co-operatives banks of Punjab. Region wise productivity as well as district wise productivity have been analysed for a period of 5 years from 2005 to 2009. The authors divided the data of the study into 3 different regions viz., Maza, Doaba and Malwa region. Statistical tools used in the study are average, ratios and growth rate. The results concluded that the Malwa region has the best position as its business per employee, income

per employee and interest income per employee is highest while Doaba region holds the second position.

Manonmani (2012) highlighted that the wage-productivity relationship in Indian industries has been ongoing and indecisive issue. The study therefore, depicts the wage productivity linkages in rural, urban and aggregate industries of India covering the periods from 1998-1999 to 2007-2008. The regression model has been used to understand the links between wages and productivity. The study computed the partial as well as total factor productivity indices. The variables used in the study are output and input. NVA (Net Value Added) has been used as output. Input includes labour and capital element where labour consists of workers directly or indirectly involved in production while capital consists of invested capital. The author suggested that the effective utilisation of the capital is the best option for neutralisation of the rise in the cost of living due to wage cost.

Reddy and Naidu (2013) in their research paper studied the productivity trends of 12 Indian cement companies for a period from the year 2000 to 2009. The study has calculated and analysed the partial factor (capital and labour) productivity and capital intensity. The labour productivity, capital productivity and capital intensity also known as capital labour ratio has been measured by using the appropriate technique. Labour productivity indices, capital productivity indices and capital intensity indices have been calculated to determine the efficiency of an individual factor input. The results of the analysis shows that the labour productivity indices of all companies has indicated the positive growth as the results are significant indicating that the labour input has a positive influence on the production of all companies. Also capital productivity indices of 9 companies showed the positive growth while rest 3 companies showed negative growth indicating the capital productivity has a negative influence on the production of all companies.

Deb and Ray (2014) has analysed in their paper total factor productivity growth in Indian manufacturing sector. The paper compares the pre and post reform performances of Indian manufacturing related to total factor productivity growth. The data envelopment analysis has been used to construct a Biennial Malmquist index for individual states. Input output data has been obtained from the annual

survey of industries for the period from1970-71 to 2007-08. The author concluded the results that at all India level, total factor productivity growth rate is higher during the post reform period. It has also been noticed that the inter-state variation in the productivity growth rate has been lower in the post reform period as compared to pre reform period.

Gorantiwar and Shrivastava (2015) in their paper, "Validating quality productivity improvement framework for sponge iron industry in India" tried to validate the quality productivity improvement framework with the help of model implementation called case study for sponge iron industry. The model has been implemented in two different sponge iron manufacturing units. The selection of units was done in such a way that both the units differ in many aspects viz. manufacturing capacity, manufacturing process, year of establishment, number of employees, location, ownership, etc. It has been observed that there is a significant relationship between the implementation factors and the performance measures of the sponge iron industry companies. It has been noted that there have been remarkable improvement over the years in the various performance indicators. The companies had accomplished both tangible and intangible benefits by practicing quality management. Also the author has concluded that the framework developed is valid and reliable and can also be implemented in other countries in this world with modification according to the environment of that country.

Taparia and Maheshwari (2015) reviewed in their study the literature related to productivity. According to the study, there are many studies available at international, national and regional level related to productivity. The study reviewed the selected literature from the year 1975 till the end of the year 2015. The study concluded that the methodology employed, nature of data used, number of variables examined, estimation procedure adopted, conclusion drawn vary widely with respect of time.

Hooda (2015) in his paper, "Productivity of state co-operative banks in India: region-wise analysis" analysed the employees' productivity performance of 31 state cooperative banks which are classified into six regions. Employees' productivity of state cooperative banks as well a branch productivity of state

cooperative banks under different regions has been analysed. The study covered a period of 10 years from 2003-04 to 2011-12. Employees' productivity has been measured on the basis of deposits per employee, credit (loan) per employee, profits per employee while the branch productivity is measured on the basis of deposits per branch, credits per branch, profits per branch. A non-parametric test – Freidman's test has been applied to test the hypothesis. The author found that the productivity of state cooperative banks of eastern region as compared to the others reported the good performance while in case of branch productivity, western regions bank has achieved the highest position. The author suggested that the StCBs should develop an electronic system for monitoring and managing the working of other branches under StCBs and also employees of these banks need to adopt themselves to a change to flourish in this competitive world.

Maheshwari (2016) in her paper "Measurement of Productivity: Various Models" explained the different categories of productivity models and their approaches as given by Sardana and Vrat. Seven models for measuring productivity had been discussed. One of the models is the Production Function Model. This model considers only labour and capital as input for calculating productivity. Another model was Economic Utility Mode. This model uses multi ratios for calculating productivity. A particular economic activity is reflected by a particular ratio. In the model, Measurement through Financial Ratio where productivity is measured by calculating the ratios such as acid test ratio, debtors turnover ratio, creditors turnover ratio, stock turnover ratio, asset turnover ratio, return on capital employed, etc. Another model is Surrogate Model, where only partial productivity is considered. It avoids the measures which are difficult to define and are unavoidable. Another model which had been talked about in the paper is the Systems Approach Based Model. It is based on the traditional method of computing output and input for calculating productivity. The second last model described is the Production Based Model. It uses the value of production. The last and the very important model discussed is the Productivity Accounting Model (PAM). This model considers all the elements of output and input, ignoring the effect of inflation. This model is known as productivity accounting model because it is based on the accounting data and also study is conducted in the field if

accounting. The study concluded that the Productivity Accounting Model has been regarded as the best model for measuring productivity

Hema (2017) analysed in her study the productivity and profitability of Indian banks as a whole. The study covers a period of 5 years from 2012-13 to 2016-17. The study was based on the secondary data obtained from the websites, annual reports of the Indian Bank and different journals and is descriptive in nature. Productivity of Indian banks has been calculated on various aspects. Employee productivity of Indian banks has been evaluated by evaluating business per employee, deposit per employee, advances per employee, net profit per employee. Productivity of branch has also been evaluated by evaluating business per branch and net profit per branch. The author has also suggested that the rightsizing of branch is the only solution to improve productivity in Indian banking industry.

Maheshwari and Taparia (2019) investigated in their paper the material productivity of pharmaceutical sector companies included in Nifty 50. The study analysed the material productivity of eight years from 2008-09 to 2015-16 of Cipla Ltd., Dr. Reddy's Laboratories Ltd., Lupin Ltd. and Sun Pharmaceutical Industries Ltd. Both intra sector and inter sector comparison has been drawn and hypotheses has been tested. For intra-sector hypothesis, an analysis has been drawn with the help of chi-square test and it has been observed that in all companies except in Sun Pharmaceutical Industries Ltd. null hypothesis has been accepted which shows that the material productivity ratios of the sampled company for the study period are approximately equal. But in Sun Pharmaceutical Industries Ltd. an alternative hypothesis is accepted. In inter-sector hypothesis, analysis is drawn with the help of Kruskal Wallis One Way Analysis of Variance Test popularly known as H Test and it has been observed that the null hypothesis is rejected which means that the material productivity ratios between the pharmaceutical sector companies included in Nifty 50 differ significantly.

Padmavati and Narayanmoorthy (2019) studied in their paper the state level data and analysed the relationship of productivity and profitability in respect of sugarcane cultivation. The study is based on the secondary data covering the period from 1973-74 to 2014-15. The relationship between them is studied with

the help of correlation and regression analysis. The study shows that the labour cost incurred in cultivating sugarcane was very high in Tamil Nadu state as compared to the other states under study. The authors suggested that the input cost that enhance the yield, plays a dominant role in increasing the productivity which may result in profitability.

Venkatesh and Saravana (2019) illustrated on improvement of productivity in context of manpower and equipment in Indian construction projects. It has been asserted that the construction productivity has been measured at three levels viz., Task level, Project level and Industry level, for which task productivity is measured by RS means method, CII method and productivity index method. The productivity has been observed to be in declining phase across the globe, majorly in construction work. The manpower and equipment productivity has been required to be looked upon at project level. It has been required to be constantly improved by practicing productivity management, providing incentives to staff and workers, forming core team to monitor productivity, looking upon on technological advancement, analyzing data on past performances and keeping a track on competitor's data.

2.4. Studies on Measurement of Productivity at International Level: A Snapshot

Author and Year	Title	Tools and Techniques Used	Findings and Conclusions	Suggestions
Islam (1990)	Measurement and Analysis of Labour Productivity: The Case of Cotton Textile Industry in Bangladesh	Based on Secondary data	There is a significant variation in the labour productivity among the three categories of firms stated in the study.	-
Dias (1991)	Factors Affecting the Productivity of Manufacturing Sector in Sri Lanka: A Spatial Analysis	Regression Analysis	The results of the study stipulated that spatial disparity of labour productivity is positively related to capital intensity and the level of urbanization and is negatively associated to the nature of enterprise.	The investigation stipulated that there is a considerable scope for increasing production in some districts in Sri Lanka.

Brynjolfsson (1993)	The Productivity Paradox of Information Technology	Descriptive Study	The research conducted indicates that there is low IT capital productivity in a variety of manufacturing and service industries. Thus, the research on information technology and productivity has been in poor position.	The author postulates that the information technology has positioned the industry for greater growth in the future.
Bjurek (1996)	The Malmquist Total Factor Productivity Index	Descriptive Study	The study stated that the Malmquist input and output quantity indexes furnish dominant information that can be used to explain the aspects of productivity changes caused by underlying economic decisions and activities.	-
Bai and Li (2004)	Industrial Productivity Convergence in China	Based on Secondary data	The study elaborates that the regional productivity is showing the significant implication for the government in policy making at both national and regional levels.	It has been suggested that the government has to play an active role in promoting these regions and should give incentives to international firms to invest in these regions.
Peslak (2004)	A firm level study of information technology productivity in Europe using financial and market based measures	Empirical Study	The conclusion of analysis found a positive relationship between IT spending and firm level productivity in European units	-
Schoer (2006)	Calculation of direct and indirect material inputs by type of raw material and economics activities	Conceptual Study	A technique known as Hybrid Input Output Table (IOT) had been developed for calculating the indirect raw material inputs.	As per the study, RME is considered as a suitable indicator to estimate the environmental pressure and to discharge the global responsibility.
Gilanyi (2007)	Some remarks on the effects of productivity on growth	Standard Economic Model and Ayres-Martina's Model	The study found that the standard economic perception that is an increase in overall productivity results in an increase in production holds good for short run only. Increased productivity may not necessarily results in increase in production in a long run.	The study suggested that this is due to the reason that all economic decisions depends on the evaluation of stocks by agents and brokers.
Inklaar and Timmer (2008)	Accounting for growth in retail trade: an international productivity comparison	Empirical Study	The study has concluded that UK and US better productivity improvement than France, Germany and Netherland, since the mid 1990's.	-
Webber, Curry and Plumbridge (2009)	Business Productivity and Area Productivity in Rural England	Survey Technique	Making use of plant level data, the study examines the presence and differences between rural and urban productivity	It has been suggested that the rural area productivity indicates critical significance informing rural area social welfare and polices for social well- being.

Simpson (2009)	Productivity in Public Services	Conceptual Study	While measuring the productivity of public services, society may prefer the public sector to deliver more services or refinement in the quality of services even at the expense of a decrease in productivity.	It further undertakes that the competition and performance incentives are regarded as the base for productivity and differences in production across organisations.
Degaspari and Fredholm (2010)	Total Factor Productivity Growth in Indian Manufacturing: A Biennial Malmquist Analysis of Inter-State Data	Biennial Malmquist Model	The study analysed that the path of the technological progress and the growth rates in labour productivity has the significant difference between the USA and U.K. and also France and Germany.	The paper has suggested to initiate an alternative method of productivity evaluation using input-output tables and production prices.
Chalermthanakom and Ueta (2011)	Impact of Environmental Regulation on Productivity: Case Studies of Three Industries in Japan	Regression Analysis	It has been found that there is no positive or negative impact of environmental regulation on traditional or environmental productivity while for automobile industries different results from the two productivity indices were found.	The study recommended that policymakers and managers should also make use of environmental productivity in their decision making processes.
Ferreira and Martinez (2011)	Intellectual Capital: Perceptions of Productivity and Investment	ANOVA and Regression Analysis	It has been concluded by the results that the companies with higher structured capital have a lower perception of productivity while higher perception of investment in marketing and sale also have higher perception of productivity.	-
Dogan, Wong and Yap (2013)	Turnover, ownership and productivity in Malaysian manufacturing	Analytical Study	It has been concluded from the study that the turnover matters regardless of ownership, but the most important thing to keep in mind is attracting foreign direct investment inflows which could give a positive effect.	It is suggested that the improvement in productivity should be in circular for long term survival of an industry in this fast changing and competitive conditions.
Jana and Petr (2013)	Profit-Sharing – A Tool for Improving Productivity, Profitability and Competitiveness of Firms	Descriptive Study	The study shows that profit-sharing may serve as a tool for increasing competitiveness but it can also be harmful when incorrectly implemented.	The author asserted that a lot of work can be possible in area of research on profit-sharing.
Rizov and Zhang (2014)	Regional disparities and productivity in China: Evidence from manufacturing micro data	Based on Secondary data	The study evaluation indicates that besides density of economic activity, recent policy and structural factors importantly affect regional productivity level and growth differentials.	-

Yildirim (2015)	Relationships among labour productivity, real wages and inflation in Turkey	Cointegration analysis and a Granger Causality Test	The study found that the inflation has a great impact on the labour productivity as compared to the real wages.	There is a broken connection among productivity and wages which is may be due to less bargaining power and structural problems comprising of high unemployment, a giant tax burden on wages, etc.
Shepotylo and Vakhitov (2015)	Services liberalization and productivity of manufacturing firms - Evidence from Ukraine	Olley Pakes Methodology	The study depicts that there is a positive effect of liberalisation of services on the productivity of manufacturing firms.	-
Fattah (2015)	Total factor productivity and technology spillovers in Egypt	Regression analysis and Hausman specification test	The study has been concluded that the technology spillovers through FDI, whether inward or outward have positive significant impact on total factor productivity.	The study suggested that the policy makers should ensure that the foreign competition could not able to destroy the domestic competitiveness, so that the nation would be able to maintain its market share of production.
Karmarkar, Kim and Rhim (2015)	Industrialization, Productivity and the Shift to Services and Information	Descriptive Study	The author established the compatibility order for income inequality in terms of either a ratio or a gap, to increase or decrease with productivity increase.	-
Mijic, Jaksic and Berber (2015)	The analysis of productivity and profitability in the CEE region: Focus on the private and the public sector	Based on Secondary data	Private sector companies performed significantly better than public sector companies in terms of profitability and productivity.	-
Ding, Guariglia and Harris (2016)	The determinants of productivity in Chinese large and medium-sized industrial firms	Based on Secondary data	When an industry and province-level decomposition is conducted it appears that the positively contributing inter-firm resources reallocation are more eminent across industries then across provinces.	-
Fresenbichler and Peneder (2016)	Innovation, competition and productivity: Firm-level evidence for Eastern Europe and Central Asia	Based on Survey	The study concluded that productivity in terms of either sales or value added per employee has been positively affected by competition and innovation. Further, this study has also been analysed that firm size, exports or population density impacts productivity positively	-

Gorden (2016)	Australia's Productivity: Some Insights from Productivity Analysis	Conceptual Study	The author investigated the need for measuring productivity due to shifts in taste and technology resulted in quality furtherance to consumer without increase in price.	To improve the productivity, the author suggested that consumers are empowered to promote welfare enhancing market solutions through client directed subsidies, forcing the firms to compete for clients, etc.
Eldridge and Price (2016)	Measuring quarterly labor productivity by industry	Based on Secondary data	The study concluded that the sustained growth in labor productivity empowers an economy to produce additional goods and services without an increase in labor resources, resulting in higher standard of living.	-
Hazarika and Boukareva (2016)	Performance analysis of major Airline companies in UAE with reference to profitability, liquidity, efficiency, employee strength and productivity	Regression Analysis	The financial performance measures of two major airlines companies of UAE viz. Emirates Airlines & Air Arabia have been compared with reference to profitability, liquidity, efficiency, employee strength and productivity.	The study elaborated that the companies can create wealth either by increasing profit per employee or by increasing the number of employees earning such profits.
Arendt and Grabowski (2017)	Innovations, ICT and ICT-driven labour productivity in Poland - A firm level approach	CDM (Crepon Duguet Mairesse) model	The study revealed that the innovation capacity, ICT implementation and use of the companies are based on the traditional sources of innovation like R&D department.	The study further proves that the utilisation of ICT become more effective only if it is accompanied by co- innovative sources of productivity.
Gu and Yan (2017)	Productivity Growth and International Competitiveness	Based on Survey	The paper analyses that the increase in effective MFP has been closely equated with the decline in output price and enhancement in international competitiveness.	The author advocated that for improving productivity industries can enhance the competitiveness of goods exports.
Abad and Ravelojaona (2017)	Exponential environmental productivity index and indicators	Based on Secondary data	The authors explained in their study Malmquist-Luenberger productivity index and Environmental-Luenberger productivity indicator.	The study recommended that an innovative advanced environmental productivity index or indicator should inherit the basic structure of the two index.
Shahbazi, Salloun, Kurdve and Wiktorsson (2017)	Material efficiency measurement: empirical investigation of manufacturing industry	Based on semi-structured interviews	It has been concluded that existing material efficiency indicators in Sweden are limited and are mainly concerned with cost or quality parameter only, environment aspects has been ignored.	-

Flachenecker (2018)	The causal impact of material productivity on macroeconomic competitiveness in the European Union	Based on Secondary data	The results indicated a casual impact of material productivity rate on wage rate and current account rate while remaining indicators are not significantly affected.	It has been suggested that through incentives including tax breaks and financial support, policy makers can convert the gains into innovations, this ultimately improve productivity and results in best use of the material input.
Berg, Marrewijk and Tammin en (2018)	Trade, productivity and profitability: On profit levels and profit margins	Melitz Model and Egger Kreickemerier Model	The relationship between the trade status, productivity and profitability has been investigated through the predictions of two models to establish the relation between the profit margins and the trade.	It has been recommended in the study that ways should be taken to adjust the Egger Kreickemerier Model so it fits the condition that profit margins rise as productivity rises for domestic firms.
Martin and Minondo (2018)	The Convergence in Product – level relative productivity across provinces	Eaton - Kortun model	The study figured out that the shorter distances, tight social ties and similar factors endowments increase the similarity in product level relative productivity between provinces.	The empirical findings also point out that measures should be taken to assist the movements of people within a country, foster knowledge flows and contribute to reduce differences in product - level relative productivity across territory.
Heil (2018)	Finance and Productivity: A Literature Review	Descriptive Study	The author studied the literature and analysed the relationship of productivity with finance, insolvency regimes, transmission channels, mergers and acquisition activity, direct contribution of the financial sector, financial liberalisation, equity finance, alternative finance, business cycles, etc.	The result suggested that the financial development has a favourable impact on productivity growth. It has also been suggested that inefficient insolvency regimes become a hurdle in the productivity growth.
Pisec and Pop (2018)	Contribution for increasing the manufacturing companies productivity using a tracking and planning production program	Conceptual Study	It has presented a tool for increasing productivity of manufacturing companies. This tool is a program developed to track all the elements involved in production process and to plan accordingly on all the phases.	It suggested that by using this tracking and planning program, the organisation can check the machine workload and its idle time and can analyse its capacity, time in which goods can be delivered and plan accordingly its selling and marketing strategies.
Adetunji, Fadun, Adetinji and Oyewole (2018)	Corporate Social Responsibility and Organisational Productivity Influence on Quality of Service Rendered By Rite Food Nigeria Limited	Questionnaire Survey	The author concluded that the Corporate Social Responsibility is responsible for the improvement of the organizational performance of productivity.	It has been recommended that the involvement of an organisation in CSR activities influences the demand to improve quality of services rendered to the ultimate consumers

Rantala, Pekkola, Rantanen and Hannula (2018)	Evolution of obstacles restraining productivity improvement	Based on Secondary Data	The study focuses on discovering the obstacles between manufacturing and service SMEs. The study concluded that there are three significant categories relating to the obstacles restraining productivity improvement. First is shift of an obstacle from internal to external, then lack of resources to lack of knowledge and ultimately a shift from lack of employees knowledge and education to lack of supervisors knowledge and education.	-
Agasisti, Munda and Hippe (2019)	Measuring the efficiency of European education systems by combining Data Envelopment Analysis and Multiple-Criteria Evaluation	Data Envelopment Analysis and Multiple – Criteria Evaluation.	The main aim of the study was to analyse the spending of European compulsory education system and allocating the ranks to the countries based on the efficiency scores given according to the spending.	It has been suggested that the policy makers should ensure to raise the average educational results without leaving disadvantaged students behind.
Aminu (2019)	Impact of Management by Objectives (MBO) on the Employee Productivity in Vodafone Ghana	Conceptual Study	The study has stated that MBO leads to professionalism, transparency, fairness, objectivity, independence and responsibility.	An organisation tries to maintain the relationship between understanding the objectives by employees/managers on one side and employee productivity on other side.
Aigbe, Ikpefan and Egolum (2019)	Technical and skilled manpower as perquisite for enhanced productivity in the construction industry	Mean, Rank, Chi-square test	The findings revealed that the factors responsible for skill shortage are low wages, high cost of training, etc. which results in increase in the cost of construction and delay in project completion.	The study recommends technological awareness and improvement in incentives for skilled manpower to encourage them to improve productivity.
Globerson and Vitner (2019)	Measuring Productivity in multi–stage, multi–product environment	Based on Secondary data	Two methodologies have been adopted for calculating the output. Firstly, equating the partial item into an equivalent number of complete items. Secondly, sum up all the outputs by assigning the weights to each and every product according to the level of usage of the most frequently used resources.	-
Baily, Bosworth and Doshi (2020)	Lessons from Productivity Comparisons of Germany, Japan and the United States	Based on OECD Statistical Data	It has been stated that industries like construction and utilities where the productivity growth has been observed extremely low or negative, suffers with the problem of regulations	It has been suggested that the benchmarking industry growth rates and setting productivity levels across countries are the only way to determine the weaknesses of the country in lagging behind and to

			and lack of effective competition.	find out areas where productivity gains can be achieved.
Adiguzel and Floros (2020)	Capacity utilisation analysis through time- driven ABC in a small- sized manufacturing company	Case Study	It has been found that time-driven activity based costing is highly applicable in the small-sized manufacturing companies due to its labour-intensive nature	It has been stated that there is a requirement of programming coding in order to capture the entanglement of the time equations and business intelligence.

2.5. Studies on Measurement of Productivity at National Level: A Snapshot

Author and Year	Title	Tools and Techniques Used	Findings and Conclusions	Suggestions
Maheshwari (1998)	Productivity Accounting in Engineering Industries in Rajasthan	Chi-square test and Kruskal Wallis one way analysis of variance test	The author sheds light on the productivity accounting model explaining the material productivity, manpower productivity, overhead productivity and overall productivity in companies of engineering industries.	The study suggested various techniques for the improvement in productivity.
Narang, Satajia and Nayyar (2010)	Productivity Analysis: A Case Study	Average, ratios and growth rate	The results concluded that Malwa region has the best position as its business per employee, income per employee and interest income per employee is highest	-
Manonmani (2012)	Wage-Productivity Linkages in Indian Industries	Regression Model	The author studied the relationship between wage rate and productivity from the various models developed in respect of rural, urban and aggregate industries of India.	The author suggested that the effective utilisation of the capital is the best option for neutralisation of the rise in the cost of living due to wage cost.
Reddy and Naidu (2013)	Partial Productivity Trends of Selected Indian Cement Companies	Based on Secondary Data	The results of the analysis shows that the labour productivity indices of all companies has indicated the positive growth while capital productivity indices of 9 companies showed the positive growth while rest 3 companies showed negative growth.	-
Deb and Ray (2014)	Total Factor Productivity Growth in Indian Manufacturing: A Biennial Malmquist Analysis of Inter-State Data	Biennial Malmquist Index	It has also been noticed that the inter-state variation in the productivity growth rate has been lower in the post reform period as compared to pre reform period.	-

Gorantiwar and Shrivastava (2015)	Validating quality productivity improvement framework for sponge iron industry in India.	Case Study	The authors tried to validate the quality productivity improvement framework with the help of model implementation called case study.	It was suggested that the framework developed is valid and reliable and can also be implemented in other countries in this world with modification according to the environment of that country.
Taparia and Maheshwari (2015)	Productivity Accounting: A Review of Literature	Descriptive Study	The study concluded that the methodology employed, nature of data used, number of variables examined, estimation procedure adopted, conclusion drawn vary widely with respect of time.	-
Hooda (2015)	Productivity of State Co-operative Banks in India: Region-wise Analysis	Friedman's Test	It was found that the productivity of state cooperative banks of eastern region reported the good performance while in case of branch productivity, western regions bank has achieved the highest position.	The paper suggested that the StCBs should develop an electronic system for monitoring and managing the working of other branches under StCBs and also employees of these banks need to adopt themselves to a change.
Maheshwari (2016)	Measurement of Productivity: Various Models	Conceptual Study	The paper explained the different categories of productivity models and their approaches as given by Sardana and Vrat.	The study suggested that the Productivity Accounting Model has been regarded as the best model for measuring productivity
Hema (2017)	A Study on the Productivity and Profitability of Indian Bank	Secondary Data	Productivity of Indian banks has been calculated on two aspects, viz., Employee productivity of Indian banks and Productivity of branch.	It has been suggested that the rightsizing of branch is the only solution to improve productivity in Indian banking industry.
Maheshwari and Taparia (2019)	Measurement of Material Productivity: A Case Study of Pharmaceutical Sector Companies included in Nifty 50	Chi-square test and Kruskal Wallis one way analysis of variance test	The paper investigated the material productivity of pharmaceutical sector companies, both intra-sector and inter-sector comparison and hypotheses testing.	-
Padmavati and Narayanmoorthy (2019)	Productivity and Profitability relationship in sugarcane cultivation: A state level analysis	Correlation and Regression analysis.	The study shows that the labour cost incurred in cultivating sugarcane was very high in Tamil Nadu state as compared to the other states under study.	It has been suggested that the input cost that enhance the yield, plays a dominant role in increasing the productivity which may results in profitability.

Venkatesh and Saravana (2019)	Improvement of Manpower and Equipment Productivity in Indian Construction Projects	RS means method, CII method and productivity index method	The productivity has been observed to be in declining phase across the globe, majorly in construction work. The manpower and equipment productivity has been required to be looked upon at project level.	The author recommended ways to improve productivity by practicing productivity management, providing incentives to staff and workers, forming core team to monitor productivity, looking upon on technological advancement, analyzing data on past performances and keeping a track on competitor's data.

2.6. Research Gap

After analysing the reviews of international as well as national level studies related to productivity of different sectors of industries, it has been observed that most of the researches are concentrated to only one factor of production. In most of the studies only single factor productivity that may be material, employee, capital, etc. calculated and has been analysed. Moreover, maximum studies are confined to a single sector only. Some studies explained the theoretical aspect of productivity and various models available for the measurement of productivity.

After analysing the reviews of stated studies, it has been concluded that there is no study has been conducted on measurement of productivity of Nifty 50 companies and also by adopting the model, "Productivity Accounting Model" advocated by H. S. Davis during the period undertaken for the study. Thus, the present study is based on the Productivity Accounting Model considering the productivity of all the factors of production of Nifty 50 companies from 2010-11 to 2017-18 i.e. for eight years period.

2.7. Concluding Observations

This chapter analyses the literature at national and international level related to productivity trends. It can be clearly seen that this is a crucial area of study as companies do not calculate the productivity of its factors of production. Companies on a large extend show the profitability in their financial statements but not showing its productivity. So this study will be helpful for the stakeholders who are interested in knowing the productivity of companies, inspite of profit and loss position. While analysing the previous literature it has been concluded that

there is no study on the companies of Nifty 50 by using Productivity Accounting Model. Therefore this study is the need of the hour.

The next chapter describes the objectives of the study and the methodology adopted to fulfill the objectives of the study.

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Chapter-3

Research Methodology

CHAPTER 3

RESEARCH METHODOLOGY

3.1. Introduction

Research is a scientific way of doing thing with the help of logical and systematized techniques which aims to discover new facts or verify the old facts, analyse their sequences, interrelationships, etc. within the specified framework of references. The methodology which is used to study the research is known as the research methodology. In other words, the various methods or ways adopted by the researcher in studying, comparing, analyzing and interpreting the research problem in accordance with the objective of research is known as the research methodology. This chapter explains the different steps taken to solve the problem, test the hypotheses and interpret the result.

The methodology and framework used in this chapter are derived from the articles published by us in different journals. (Reference No. 7 to 13)

3.2. Main Objectives of the Research

In the present study, an attempt has been made to measure, analyse, compare and suggest the concepts regarding productivity as material productivity, labour productivity, overhead productivity and overall productivity in different industries of Indian economy, during the period from 2010-11 to 2017-18.

The main objectives can be summarized as follows:-

1) To understand about the various approaches of productivity measurement especially in the context of Indian economy.
2) To examine the cornerstones of productivity measurement and the techniques influencing for improvement in productivity.
3) To measure, analyse and compare the material productivity for the sampled companies included in Nifty 50.
4) To measure, analyse and compare the labour productivity for the sampled companies included in Nifty 50.

5) To measure, analyse and compare the overhead productivity for the sampled companies included in Nifty 50.
6) To measure, analyse and compare the overall productivity for the sampled companies included in Nifty 50.
7) To identify the areas wherein further improvements in terms of material productivity, labour productivity and overhead productivity are necessary.
8) To suggest various measures to improve material, labour and overhead productivity.

3.3. Selection of Sample

A sample of companies has been selected from the Nifty 50. The Nifty 50 is a composite of the top 50 stocks listed on the National Stock Exchange (NSE). Out of the 50 companies a sample of 24 companies has been drawn. These companies have been selected from Automobile, Energy, Information Technology, Metals, Pharmaceutical and Refineries sector which has a great impact on the economy of our country. Four companies have been selected from each sector according to the higher market capitalization of company. Financial institution, banking, telecommunication companies, etc. have been ignored while selecting the companies as material aspect of overall input is not there in the financial statements of these companies. Some companies have been ignored on the ground that only single company of that sector is included in Nifty 50. The selected companies and their websites are being shown in the following table:

Table 3.1

Details of Companies and their Websites

S. No.	Sector	Company	Website
1	Automobile Sector	Bajaj Auto Ltd.	www.bajajauto.com
2		Mahindra & Mahindra Ltd.	www.mahindra.com
3		Maruti Suzuki India Ltd.	www.marutisuzuki.com
4		Tata Motors Ltd.	www.tatamotors.com
5	Energy Sector	Gail (India) Ltd.	www.gailonline.com
6		NTPC Ltd.	www.ntpc.co.in
7		Oil and Natural Gas Corporation Ltd.	www.ongcindia.com
8		Power Grid Corporation of India Ltd.	www.powergridindia.com

9	Information Technology Sector	Infosys Ltd.	www.infosys.com
10		Tata Consultancy Services Ltd.	www.tcs.com
11		Tech Mahindra Ltd.	www.techmahindra.com
12		Wipro Ltd.	www.wipro.com
13	Metals Sector	Coal India Ltd.	www.coalindia.in
14		Hindalco Ltd.	www.hindalco.com
15		Tata Steel Ltd.	www.tatasteel.com
16		Vedanta Ltd.	www.vedantalimited.com
17	Pharmaceutical Sector	Cipla Ltd.	www.cipla.com
18		Dr. Reddy's laboratories Ltd.	www.drreddys.com
19		Lupin Ltd.	www.lupin.com
20		Sun Pharmaceutical Industries Ltd.	www.sunpharma.com
21	Refineries Sector	Bharat Petroleum Corporation Ltd.	www.bharatpetroleum.com
22		Hindustan Petroleum Corporation Ltd.	www.hindustanpetroleum.com
23		Indian Oil Corporation Ltd.	www.iocl.com
24		Reliance Industries Ltd.	www.ril.com

Source: https://www.nseindia.com/products/content/equities/indices/nifty_50.htm on 25.07.2018.

3.4. Importance of Nifty 50 Companies

The Nifty 50 is the standard Indian stock market representing 50 of the largest Indian companies listed on National Stock Exchange (NSE). The Index tracks the behavior of a portfolio of blue chip companies, the largest and most liquid Indian securities.

The Nifty 50 covers major sectors of the Indian economy and offers investment managers to exposure to the Indian market with an efficient portfolio.

Thus, this research studies the selected companies which are included in Nifty 50 through covering the major sectors of Indian economy.

3.5. Type of Research

The present study is explorative, conceptual and empirical in nature. The **explorative** studies tend to explore the research topic with varying levels of depth with the objective of discovering future research tasks. The immediate purpose of exploration is usually to develop hypotheses or questions for further research. This

study also focuses on the development of hypotheses and analysis of the data and finds out the scope of future.

The **empirical** study is the one based on the observation and experiences from the data available quantitatively and qualitatively. This study is also based on the quantitative data obtained from the secondary sources.

From **conceptual** viewpoint, the study has examined the meaning, history, purpose and importance of productivity measurement. It also explains in detail the concept of overall and partial productivity, factors influencing productivity, techniques for improving productivity, etc.

3.6. Research Design

3.6.1. Collection of Data

This research is based on the secondary data. The data and information regarding output, sales, material consumed, total inputs and all other financial variables have been obtained from the annual reports of the respective companies. The annual reports are available on the website of the companies. Data from the standalone financial statements have been used for the purpose of analysis and interpretation. To remove the inflation effect of prices on outputs and inputs, the revaluation of the values of outputs and inputs have been made. For the revaluation of values, index numbers have been used. The index numbers used in the study have been collected from the various bulletins published by Reserve Bank of India on its website. After extracting the secondary data from the original sources, classification tables will be prepared and will be taken directly for analysis and interpretation.

3.6.2. Period of Study

The present study covers a period of eight financial years from 2010-11 to 2017-18.

3.6.3. Selection of Base Year

The year 2010-11 has been taken as the base year. The revaluation of output and inputs has been done on the basis of base year prices.

3.6.4. Model to be Used

In the present research work the model propogated by H. S. Davis which is Productivity Accounting Model has been used for measuring productivity. It has been used because it considers all the elements of output and input, ignoring the effect of inflation. According to Sardana and Vrat, "This model is known as productivity accounting model because it is based on the accounting data and the study is also being conducted in the field of accounting." According to this model productivity is calculated by applying the formula **output divided by input**. This model suggests that the output as well as input should be measured in terms of money so that the comparison is possible as for all companies the base of measurement is monetary. If the output is measured in terms of units then it is very much difficult to compare and analyse it and draw a conclusion from it. This model also suggests that there is a change in the price level. This change is due to the inflation which prevails in our economy. Due to this inflation the purchasing power of rupee is decreasing day by day. To overcome the problem this method suggests that the output and inputs should be revalued taking the base year prices so that the effect of inflation can be removed and making the analysis more useful and helpful.

3.6.5. Variables Used

The variables used in the present study are output and input. For calculating output and input monetary values have been considered. Output and input both have been revalued on the basis of price index with reference to the base year.

Output and Input are being described below:

1. Output

As per Cambridge Dictionary, "Output is an amount of something produced by a person, machine, factory, country, etc." The first and foremost thing which comes in our mind about output is how much quantity in units has been produced or how much of quantity in units has been sold. By comparing the both it is preferable that for obtaining the output one should use the quantity in units which has been produced because productivity is also linked with the production. But there are limitations if the output is expressed in number of units. Firstly, a company may engage in variety of products and it becomes very difficult for the

company to express its output in number of units. Secondly, different companies produce different products. There is no similarity of products between the two companies also there is no uniformity of units which can be expressed in output. To overcome this complexity it is suggested that money values can be used for obtaining the output. This can only be the common platform for obtaining output and various other input as required in the study.

Output may consist of the following:

1. Revenue from operations
2. Other income
3. Changes in the inventories of finished goods, work in progress and traded goods.

2. Input

Different authors have classified input in different ways. As per this research work input has been classified into three main categories which is material, labour and overhead. All the expenses are broadly classified under these heads. Monetary values have been used for obtaining various inputs. Material input consists of raw material and components, stores and spares and purchases of traded goods. Labour input consists of salary, wages, bonus and benefits, contribution to provident and other funds and employees welfare expenses and others. All the remaining is covered under the overhead input. Overheads have been divided into major four heads power and fuel, depreciation and amortization, repairs and maintenance and lastly business service input. Business service input includes all the other overhead expenses which are not covered under the above three heads.

One more thing is added in the input that is the investor input. It is an additional cost for which the company pays the cost i.e. interest, royalty, profit, etc.

Although the classification is not according to the definition of costing but this is necessary to make the research more meaningful and useful.

3.6.6. Revaluation of Output and Input

According to Maheshwari, M. (1998), there are two ways for the revaluation of output and input. The first way says that base year output can be used for revaluating the output and according to the second way, price index with respect

to the base year can be used for revaluating the output and the input. The second way has been adopted in the present study to revaluate the output and input as it seems to be more reliable and valuable.

Revaluation of the output of different companies of the different sectors have been calculated and shown in the Appendix 3.1 to 3.24.

Revaluation of the input of different companies of the different sectors have been calculated and shown in the Appendices of the related chapter.

3.6.7. Calculation of Index Numbers and Conversion Factors

Index numbers and conversion factors have been used for revaluation of data as per the base year's prices for eight years from 2010-11 to 2017-18. Consumer price index for industrial workers has been used for revaluating labour input. Fuel and power index has been used for revaluating fuel and power expenses in the overhead input. And in rest of the cases wholesale price index has been used for revaluation. Here the year 2010-11 has been taken as base year.

Following formula has been used to calculate conversion factors:

Index number of the base year

Index number for the current year

Revaluated output as well as revaluated input can be obtained by multiplying conversion factors with the actual values of output as well as of input.

Table 3.2

Index Numbers and the Conversion Factors for Revaluation of Data

Year	Wholesale Price Index Base year 2011-12 = 100	Conversion Factors	Consumer Price Index for Industrial Workers Base Year 2001 = 100	Conversion Factors	Fuel and Power Index Base Year 2011-12 = 100	Conversion Factors
2010-11	91.80	1.000	180.00	1.000	87.75	1.000
2011-12	100.00	0.918	195.00	0.923	100.00	0.878
2012-13	106.90	0.859	215.00	0.837	107.10	0.819
2013-14	112.50	0.816	236.00	0.763	114.70	0.765
2014-15	113.90	0.806	251.00	0.717	107.70	0.815
2015-16	109.70	0.837	265.00	0.679	86.50	1.014
2016-17	111.60	0.823	276.00	0.652	86.30	1.017
2017-18	114.90	0.799	284.00	0.634	93.30	0.941

Backward Splicing technique has been used for calculating the index numbers of 2010-11. Formula for splicing the index number of 2010-11 is as follows:

Current year's Old Index Number X 100

Old Index Number of New base year

Wholesale Price Index (with base year 2004-05) of 2010-11 is 143.32 and 2011-12 is 156.13. Wholesale price Index (with base year 2011-12) of 2010-11 has been calculated as follows:

$\frac{143.32}{156.13} \times 100 = 91.80$

Fuel and Power Index (with base year 2004-05) of 2010-11 is 148.32 and 2011-12 is 169.03. Fuel and Power Index (with base year 2011-12) of 2010-11 has been calculated as follows:

$\frac{148.32}{169.03} \times 100 = 87.75$

3.7. Research Hypotheses

Keeping in mind the objectives of the research work the following hypotheses have been developed and will be tested with the help of non-parametric test.

3.7.1. For Intra-company Comparison

Four hypotheses have been developed and will be tested for intra-company comparison. Intra-company hypotheses will be tested and analysed with the help of the non-parametric chi-square test.

1) **Material Productivity:** To measure, analyse and compare the material productivity ratios and indices of the sampled company for the study period following hypothesis has been developed which will be tested.

Null Hypothesis (H_0): There is no significant difference in the material productivity indices of the sampled company for the study period and can be represented by straight line trend or line of best fit.

Alternative Hypothesis (H_1): There is a significant difference in the material productivity indices of the sampled company for the study period and cannot be represented by straight line trend or line of best fit.

The acceptance of null hypothesis would reveal that the material productivity indices of the sampled company for the study period are approximately equal and

can be represented by straight line trend or line of best fit. However, rejection of null hypothesis and acceptance of alternate hypothesis would mean that the material productivity indices of the sampled company differ in the study period indicates that indices cannot be represented by straight line trend.

2**) Labour Productivity**: To measure, analyse and compare the labour productivity ratios and indices of the sampled company for the study period the following hypothesis has been developed which will be tested.

Null Hypothesis (H_0): There is no significant difference in the labour productivity indices of the sampled company for the study period and can be represented by straight line trend or line of best fit.

Alternative Hypothesis (H_1): There is a significant difference in the labour productivity indices of the sampled company for the study period and cannot be represented by straight line trend or line of best fit.

The acceptance of null hypothesis would decide that the labour productivity indices of the sampled company for the study period are approximately equal and can be represented by straight line trend or line of best fit. However, rejection of null hypothesis and acceptance of alternative hypothesis would mean that the labour productivity indices of the sampled company differ in the study period indicates that indices cannot be represented by straight line trend.

3) **Overhead Productivity**: To measure, analyse and compare the overhead productivity ratios and indices of the sampled company for the study period following hypothesis has been developed tested.

Null Hypothesis (H_0): There is no significant difference in the overhead productivity indices of the sampled company for the study period and can be represented by straight line trend or line of best fit.

Alternative Hypothesis (H_1): There is a significant difference in the overhead productivity indices of the sampled company for the study period and cannot be represented by straight line trend or line of best fit.

The acceptance of null hypothesis discloses that the overhead productivity indices of the sampled company for the study period are approximately equal and can be represented by straight line trend or line of best fit. However, rejection of null hypothesis and acceptance of alternative hypothesis would mean that the overhead productivity indices of the sampled company differ in the study period indicates that indices cannot be represented by straight line trend.

4) **Overall Productivity**: To measure, analyse and compare the overall productivity ratios and indices of the sampled company for the study period following hypothesis has been developed which will be tested.

Null Hypothesis (H_0): There is no significant difference in the overall productivity indices of the sampled company for the study period and can be represented by straight line trend or line of best fit.

Alternative Hypothesis (H_1): There is significant difference in the overall productivity indices of the sampled company for the study period and cannot be represented by straight line trend or line of best fit.

The acceptance of null hypothesis would indicate that the overall productivity indices of the sampled company for the study period are approximately equal and can be represented by straight line trend or line of best fit. However, rejection of null hypothesis and acceptance of alternative hypothesis would mean that the overall productivity indices of the sampled company differ in the study period indicates that indices cannot be represented by straight line trend.

3.7.2. For Inter-company Comparison

A comparison and analysis will be drawn between the sampled 24 companies. To compare the different companies of different sectors four hypotheses have been developed which will be tested. For testing the hypotheses, non-parametric kruskal wallis one way analysis of variance test popularly known as H Test will be used.

1) **Material Productivity**: To measure, analyse and compare the material productivity ratios of sampled companies, following hypothesis has been developed which will be tested.

Null Hypothesis (H_0): There is no significant difference in the material productivity ratios of sampled companies.

Alternative Hypothesis (H_1): There is a significant difference in the material productivity ratios of sampled companies.

The acceptance of null hypothesis would reflect that the material productivity ratios of sampled companies are approximately equal. However, rejection of null hypothesis and acceptance of alternative hypothesis would mean that the material productivity ratios between the sampled companies differ.

2) **Labour Productivity**: To measure, analyse and compare the labour productivity ratios of sampled companies following hypothesis has been developed which will be tested.

Null Hypothesis (H_0): There is no significant difference in the labour productivity ratios of sampled companies.

Alternative Hypothesis (H_1): There is a significant difference in the labour productivity ratios of sampled companies.

The acceptance of null hypothesis would reveal that the labour productivity ratios of sampled companies are approximately equal. However, rejection of null hypothesis and acceptance of alternative hypothesis would mean that the labour productivity ratios between the sampled companies differ.

3) **Overhead Productivity**: To measure, analyse and compare the overhead productivity ratios of sampled companies following hypothesis has been developed which will be tested.

Null Hypothesis (H_0): There is no significant difference in the overhead productivity ratios of sampled companies.

Alternative Hypothesis (H_1): There is a significant difference in the overhead productivity ratios of sampled companies.

The acceptance of null hypothesis would conclude that the overhead productivity ratios of sampled companies are approximately equal. However, rejection of null hypothesis and acceptance of alternative hypothesis would mean that the overhead productivity ratios between the sampled companies differ.

4) **Overall Productivity**: To measure, analyse and compare the overall productivity ratios of sampled companies following hypothesis has been developed which will be tested.

Null Hypothesis (H_0): There is no significant difference in the overall productivity ratios of sampled companies.

Alternative Hypothesis (H_1): There is a significant difference in the overall productivity ratios of sampled companies.

The acceptance of null hypothesis would convey that the overall productivity ratios of sampled companies are approximately equal. However, rejection of null hypothesis and acceptance of alternative hypothesis would mean that the overall productivity ratios between the sampled companies differ.

3.8. Research Hypotheses Testing

In the present study, hypotheses will be tested with the help of two tests. Intra-company hypotheses will be tested and analysed with the help of chi-square test while the inter-company hypotheses will be tested and analysed on the basis of kruskal wallis one way analysis of variance test.

Both the test has been explained below:

3.8.1. Chi-square Test (χ^2)

Chi-square is most widely used non-parametric test. It is statistic and not a parameter because there are no parameters corresponding to it. It is the simplest and easiest test to apply on variables. Chi (χ) is originated from the Greek letter. It is also pronounced as 'ki'. The most important advantage of using this test is that no assumption about the form of the original distribution from which the

observation come is involved in it. It also be noted that the value of chi-square is always positive and its upper limit is infinity. It is defined as

$$\text{Chi-square } (\chi^2) = \sum \frac{(O - E)^2}{E}$$

Where, O = Observed Values

E = Expected Values

Following steps have been used for calculating the chi-square:

1. First of all expected values have been calculated by using the least square method.
2. Difference between the observed and expected values and their square is calculated viz. $(O - E)^2$
3. $(O - E)^2$ is divided by the E and its total is calculated. This gives the value of chi-square.

- If the chi-square is zero it means the observed and expected values completely coincide. The greater the discrepancy between the observed and the expected values the greater shall be the value of chi-square.
- If the calculated value is smaller than the table value then the difference is not significant.

  CV < TV, Difference Not Significant, Null Hypothesis Accepted
- If the calculated value is greater than the table value then the difference is significant.

  CV > TV, Difference Significant, Null Hypothesis rejected.

3.8.2. Kruskal Wallis One Way Analysis of Variance Test or H Test

If several independent samples are involved in the study the best way to analyse the data is Kruskal Wallis one way analysis of variance or H test. This test helps in testing the null hypothesis against the alternative hypothesis. H value has been calculated by applying the following formula:

$$H = \frac{12}{N(N+1)} \left(\sum_{j=1}^{k} \frac{(Rj)^2}{nj} \right) - 3(N+1)$$

Where, N = Number of observations

k = Total number of sample

Rj = Sum of rank in j^{th} sample

nj = Number of observations in j^{th} sample

Following steps have been used for calculating the kruskal wallis one way analysis of variance test:

1. All the data are to be ranked as if they were in one sample, from lowest to highest.
2. Where the tie occur the mean of the available rank numbers is used.
3. The rank sums of each sample are calculated and H statistic has been calculated by applying the formula.
4. H Test follows the chi-square distribution with (k-1) degree of freedom. k is the number of samples.

- If the calculated value is smaller than the table value then the difference is not significant.

  CV < TV, Difference Not Significant, Null Hypothesis Accepted

- If the calculated value is greater than the table value then the difference is significant.

  CV > TV, Difference Significant, Null Hypothesis rejected.

3.9. Other Statistical Tools and Techniques Used

The various other statistical tools and techniques used in the study are as follows:

1. Mean (Average)
2. Least Square Method has been used for calculating the expected values in Chi-square Test
3. Ranks have been assigned to the values for calculating the Kruskal Wallis One Way Analysis of Variance Test.
4. Standard Deviation
5. Coefficient of Variation
6. Percentage methods have been used for analyzing and testing the formulated hypotheses.

3.10. Expected Contribution from the Research

The study is expected to provide the following:

1. Literature

This study will provide the base for future research as a literature review in the field of accounting. The different productivity models advocated by renowned national as well as international authors have been detailed to help the researchers in adopting the method of analysis for their work.

2. Society

This study will also prove helpful for society because it is based on the productivity, not the profitability. The stakeholders of companies are more concerned about the profitability rather than productivity but society is more concerned about the scarce resources. The optimum utilisation of resources can be ensured only by maintaining and improving productivity. The productivity of resources in terms of maximum output with lesser amount of input can be achieved by using the available resources effectively and efficiently. It is through productivity that the per capita income will increase which results in the improvement in the standard of living and ultimately leads to the development of the society. Moreover, if the company will work upon its productivity it will be able to provide the desired output to the ultimate consumers as and when they need at affordable prices.

3. Corporates

All the companies would be increasing their reputation among stakeholders by adopting methods to increase productivity and effective utilization of resources. They can adopt this study as a base for adopting techniques stated in it which results in increase in productivity.

4. Government and Policy Makers

This study will also be helpful for the government and the policy makers as they are able to know whether the corporates in the economy of the country are effectively and efficiently using the resources or not. This study helps the policy makers in making the laws and regulations which depicts the true and fair view of the company among its stakeholders.

5. Nation

Higher productivity increases the per capita income, ensures greater national wealth, better utilisation of resources, expansion of international market with the help of standardised goods and services at cheaper rates.

6. Researcher

This study in its usual course, offers scope for future research in the areas such as production function analysis of both regional and national level companies, cost function analysis of national as compared to international level companies.

3.11. Referencing

Referencing has been made as per 6th edition of standard format recommended by American Psychological Association (APA).

3.12. Concluding Observations

Through this chapter, one can understand the methodology adopted in performing the research. This chapter states the main objectives of the research and also the methodology adopted in attaining the said objectives. It also states that the research is based on the secondary data which is obtained from the annual report of the respective companies. A sample of 24 companies included in Nifty 50 for the period from 2010-11 to 2017-18 has been selected for research. Productivity accounting model propagated by H. S. Davis has also been used for measuring productivity. Keeping in mind the objectives of the research, intra-company and inter-company hypotheses have been developed and will be tested.

Next chapter deals with the material productivity aspect. Material input and productivity has been calculated and with its help material productivity indices has been determined.

Appendices

Appendix 3.1 to 3.4. Revaluation of Output of Automobile Sector Companies

Appendix 3.1

Revaluation of Output of Bajaj Auto Ltd. from 2010-11 to 2017-18.

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	16398.23	19528.98	17927.60	19997.25	17177.64	20149.51	16442.00	21612.01	17419.28	22687.59	18989.51	21766.68	17913.98	25164.92	20106.77
2	Other Income	576.51	608.04	558.18	795.49	683.33	706.41	576.43	582.42	469.43	913.27	764.41	1221.97	1005.68	1347.25	1076.45
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	-82.79	-94.15	-86.43	24.00	20.62	-18.90	-15.42	-57.56	-46.39	63.45	53.11	-43.68	-35.95	9.68	7.73
	Total Output	16891.95	20042.87	18399.35	20816.74	17881.58	20837.02	17003.01	22136.87	17842.32	23664.31	19807.03	22944.97	18883.71	26521.85	21190.96

Appendix 3.2

Revaluation of Output of Mahindra & Mahindra Ltd. from 2010-11 to 2017-18.

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	23460.26	31853.52	29241.53	40441.16	34738.96	40508.50	33054.94	38444.83	30986.53	40884.98	34220.73	44053.50	36256.03	48685.55	38899.75
2	Other Income	434.15	465.79	427.60	549.17	471.74	717.99	585.88	848.94	684.25	854.85	715.51	1345.46	1107.31	1036.36	828.05
3	Changes in Inventories of Finished Goods, Work in progress, Stock in Trade and manufactured components	-202.23	-597.33	-548.35	-78.03	-67.03	-274.67	-224.13	323.63	260.85	-215.80	-180.62	57.87	47.63	194.87	155.70
	Total Output	23692.18	31721.98	29120.78	40912.30	35143.67	40951.82	33416.69	39617.40	31931.62	41524.03	34755.61	45456.83	37410.97	49916.78	39883.51

Appendix 3.3

Revaluation of Output of Maruti Suzuki India Ltd. from 2010-11 to 2017-18.

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	36618.40	35587.10	32668.96	43587.90	37442.01	43700.60	35659.69	49970.60	40276.30	57746.30	48333.65	68034.80	55992.64	79762.70	63730.40
2	Other Income	508.80	826.80	759.00	812.40	697.85	822.90	671.49	831.60	670.27	461.90	386.61	2300.10	1892.98	2045.50	1634.35
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	-56.00	-131.20	-120.44	23.40	20.10	18.50	15.10	-455.90	-367.46	6.90	5.78	-380.10	-312.82	40.70	32.52
	Total Output	37071.20	36282.70	33307.52	44423.70	38159.96	44542.00	36346.27	50346.30	40579.12	58215.10	48726.04	69954.80	57572.80	81848.90	65397.27

Appendix 3.4

Revaluation of Output of Tata Motors Ltd. from 2010-11 to 2017-18.

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	47088.44	54306.56	49853.42	44765.72	38453.75	34288.11	27979.10	36301.63	29259.11	42369.82	35463.54	44316.24	36472.27	58831.41	47006.30
2	Other Income	422.97	574.08	527.01	2088.20	1793.76	3833.03	3127.75	1881.41	1516.42	2132.92	1785.25	981.06	807.41	1557.60	1244.52
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	-354.22	-623.84	-572.69	-143.60	-123.35	371.72	303.32	-878.82	-708.33	22.94	19.20	-252.14	-207.51	842.05	672.80
	Total Output	47157.19	54256.80	49807.74	46710.32	40124.16	38492.86	31410.17	37304.22	30067.20	44525.68	37267.99	45045.16	37072.17	61231.06	48923.62

Appendix 3.5 to 3.8. Revaluation of Output of Energy Sector Companies

Appendix 3.5

Revaluation of Output of GAIL (India) Ltd. from 2010-11 to 2017-18.

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	32536.52	40397.95	37085.32	47522.69	40821.99	57507.93	46926.47	56741.98	45734.04	51914.15	43452.14	48148.85	39626.50	53661.58	42875.60
2	Other Income	440.70	431.88	396.47	764.51	656.71	898.52	733.19	860.86	693.85	857.70	717.89	1176.27	968.07	987.00	788.61
3	Changes in Inventories of Finished Goods, Work in progress and Stock in Trade	-132.49	-497.75	-456.93	-56.98	-48.95	-626.86	-511.52	232.17	187.13	411.55	344.47	42.29	34.80	-34.12	-27.26
	Total Output	32844.73	40332.08	37024.85	48230.22	41429.76	57779.59	47148.15	57835.01	46615.02	53183.40	44514.51	49367.41	40629.38	54614.46	43636.95

Appendix 3.6

Revaluation of Output of NTPC Ltd. from 2010-11 to 2017-18.

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	55062.65	62052.23	56963.95	65673.93	56413.91	72018.93	58767.45	73236.94	59028.97	70506.80	59014.19	78273.44	64419.04	83452.70	66678.71
2	Other Income	2344.65	2778.42	2550.59	3101.58	2664.26	2688.89	2194.13	2100.42	1692.94	1189.27	995.42	1068.86	879.67	1755.25	1402.44
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods			0.00		0.00		0.00		0.00		0.00		0.00		0.00
	Total Output	57407.30	64830.65	59514.54	68775.51	59078.16	74707.82	60961.58	75337.36	60721.91	71696.07	60009.61	79342.30	65298.71	85207.95	68081.15

Appendix 3.7

Revaluation of Output of Oil and Natural Gas Corporation Ltd. from 2010-11 to 2017-18.

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	65845.00	76515.09	70240.85	83005.33	71301.58	83890.27	68454.46	82870.96	66793.99	78368.07	65594.07	77907.73	64118.06	85004.10	67918.28
2	Other Income	5900.77	4452.98	4087.84	5436.74	4670.16	6713.20	5477.97	5366.57	4325.46	6192.17	5182.85	7676.34	6317.63	7883.54	6298.95
3	Changes in Inventories of Finished Goods and Work in progress	-12.91	-91.34	-83.85	-23.02	-19.77	104.28	85.09	-167.43	-134.95	18.67	15.63	-132.84	-109.33	-63.02	-50.35
	Total Output	71732.86	80876.73	74244.84	88419.05	75951.96	90707.75	74017.52	88070.10	70984.50	84578.91	70792.55	85451.23	70326.36	92824.62	74166.87

Appendix 3.8

Revaluation of Output of Power Grid Corporation of India Ltd. from 2010-11 to 2017-18.

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	8388.7	10035.3	9212.43	12757.9	10958.99	15230.28	12427.91	17177.2	13844.85	20802.2	17411.46	25710.1	21159.39	29752.46	23772.22
2	Other Income	710.05	749.68	688.21	570.89	490.39	491.13	400.76	602.81	485.86	478.96	400.89	866.63	713.24	1013.86	810.07
	Total Output	9098.75	10785.01	9900.64	13328.74	11449.39	15721.41	12828.67	17780.04	14330.71	21281.18	17812.35	26576.70	21872.62	30766.32	24582.29

Appendix 3.9 to 3.12 Revaluation of Output of Information Technology Sector Companies

Appendix 3.9

Revaluation of Output of Infosys Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Income from software services and products	25385.00	31254.00	28691.17	36765.00	31581.14	44341.00	36182.26	47300.00	38123.80	53983.00	45183.77	59289.00	48794.85	61941.00	49490.86
2	Other Income	1147.00	2313.00	2123.33	2298.00	1973.98	2576.00	2102.02	3337.00	2689.62	3009.00	2518.53	3062.00	2520.03	4019.00	3211.18
	Total Output	26532.00	33567.00	30814.51	39063.00	33555.12	46917.00	38284.27	50637.00	40813.42	56992.00	47702.30	62351.00	51314.87	65960.00	52702.04

Appendix 3.10

Revaluation of Output of Tata Consultancy Services Ltd from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	29275.41	38858.54	35672.14	48426.14	41598.05	64672.93	52773.11	73578.06	59303.92	85863.85	71868.04	92693	76286.34	97356	77787.44
2	Other Income	494.73	2685.18	2465.00	2230.39	1915.91	3114.71	2541.60	4466.73	3600.18	3740.20	3130.55	4568.00	3759.46	5803.00	4636.60
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	0.87	0.26	0.24	0.00	0.00	-0.07	-0.06	0.15	0.12	0.38	0.32	-1.00	-0.82	1.00	0.80
	Total Output	29771.01	41543.98	38137.37	50656.53	43513.96	67787.57	55314.66	78044.94	62904.22	89604.43	74998.91	97260.00	80044.98	103160.00	82424.84

Appendix 3.11

Revaluation of Output of Tech Mahindra Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	4965.50	5243.00	4813.07	6001.90	5155.63	16295.10	13296.80	19162.70	15445.14	20969.80	17551.72	23165.40	19065.12	23661.20	18905.30
2	Other Income	126.60	67.70	62.15	-95.20	-81.78	70.30	57.36	124.50	100.35	1108.40	927.73	892.90	734.86	1730.70	1382.83
	Total Output	5092.10	5310.70	4875.22	5906.70	5073.86	16365.40	13354.17	19287.20	15545.48	22078.20	18479.45	24058.30	19799.98	25391.90	20288.13

Appendix 3.12

Revaluation of Output of Wipro Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	26300.50	31682.90	29084.90	33226.50	28541.56	38757.20	31625.88	41209.80	33215.10	44684.60	37401.01	46047.80	37897.34	44710.00	35723.29
2	Other Income	680.70	1227.40	1126.75	1325.30	1138.43	1611.20	1314.74	2499.00	2014.19	2771.50	2319.75	2645.90	2177.58	2479.60	1981.20
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	-31.60	44.90	41.22	-18.20	-15.63	0.90	0.73	-254.30	-204.97	-53.10	-44.44	164.00	134.97	57.70	46.10
	Total Output	26949.60	32955.20	30252.87	34533.60	29664.36	40369.30	32941.35	43454.50	35024.33	47403.00	39676.31	48857.70	40209.89	47247.30	37750.59

Appendix 3.13 to 3.16 Revaluation of Output of Metals Sector Companies

Appendix 3.13

Revaluation of Output of Coal India Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	409.46	415.86	381.76	352.25	302.58	314.25	256.43	387.12	312.02	165.53	138.55	289.88	238.57	364.50	291.24
2	Other Income	5072.50	9101.71	8355.37	11088.01	9524.60	16089.85	13129.32	14143.40	11399.58	17127.10	14335.38	15004.75	12348.91	9571.03	7647.25
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	-8.54	17.06	15.66	2.54	2.18	-25.03	-20.42	-18.23	-14.69	-94.55	-79.14	83.49	68.71	42.09	33.63
	Total Output	5473.42	9534.63	8752.79	11442.80	9829.37	16379.07	13365.32	14512.29	11696.91	17198.08	14394.79	15378.12	12656.19	9977.62	7972.12

Appendix 3.14

Revaluation of Output of Hindalco Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	23859.21	26596.78	24415.84	26056.93	22382.90	27850.93	22726.36	34525.03	27827.17	34317.66	28723.88	36936.61	30398.83	42798.04	34195.63
2	Other Income	347.49	615.79	565.30	983.09	844.47	1124.42	917.53	882.21	711.06	1066.21	892.42	1005.17	827.25	947.82	757.31
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	-394.67	-407.31	-373.91	127.94	109.90	-676.21	-551.79	67.81	54.65	191.70	160.45	-1100.16	-905.43	-419.23	-334.96
	Total Output	23812.03	26805.26	24607.23	27167.96	23337.28	28299.14	23092.10	35475.05	28592.89	35575.57	29776.75	36841.62	30320.65	43326.63	34617.98

Appendix 3.15

Revaluation of Output of Tata Steel Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	29396.35	33933.46	31150.92	38199.43	32813.31	41711.03	34036.20	41785.00	33678.71	38210.34	31982.05	53260.96	43833.77	60519.37	48354.98
2	Other Income	528.36	886.43	813.74	902.04	774.85	787.64	642.71	582.78	469.72	3890.70	3256.52	414.46	341.10	763.66	610.16
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	-173.65	-220.72	-202.62	-404.60	-347.55	-155.18	-126.63	-715.94	-577.05	142.97	119.67	-1329.65	-1094.30	545.36	435.74
	Total Output	29751.06	34599.17	31762.04	38696.87	33240.61	42343.49	34552.29	41651.84	33571.38	42244.01	35358.24	52345.77	43080.57	61828.39	49400.88

Appendix 3.16

Revaluation of Output of Vedanta Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	7493.08	6513.45	5979.35	2347.63	2016.61	28536.53	23285.81	32502.41	26196.94	29810.62	24951.49	36663.00	30173.65	45524.00	36373.68
2	Other Income	515.20	386.33	354.65	341.99	293.77	1817.06	1482.72	2008.86	1619.14	8823.82	7385.54	9705.00	7987.22	3866.00	3088.93
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	-12.13	48.56	44.58	-205.77	-176.76	-556.86	-454.40	263.80	212.62	131.54	110.10	-417.00	-343.19	-11.00	-8.79
	Total Output	7996.15	6948.34	6378.58	2483.85	2133.63	29796.73	24314.13	34775.07	28028.71	38765.98	32447.13	45951.00	37817.67	49379.00	39453.82

Appendix 3.17 to 3.20 Revaluation of Output of Pharmaceutical Sector Companies

Appendix 3.17

Revaluation of Output of Cipla Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	6135.16	6977.5	6405.35	8202.42	7045.88	9380.29	7654.32	10131.78	8166.21	12034.06	10072.51	10974.58	9032.08	11444.81	9144.40
2	Other Income	298.72	148.3	136.14	229.13	196.82	280.28	228.71	147.91	119.22	259.14	216.90	129.85	106.87	334.88	267.57
3	Changes in Inventories of Finished Goods, Work in progress and Traded	-125.74	11.24	10.32	-290.75	-249.75	-158.12	-129.03	-349.05	-281.33	228.35	191.13	56.27	46.31	-212.05	-169.43
	Total Output	6308.14	7137.04	6551.80	8140.80	6992.95	9502.45	7754.00	9930.64	8004.10	12521.55	10480.54	11160.70	9185.26	11567.64	9242.54

Appendix 3.18

Revaluation of Output of Dr. Reddy's Laboratories Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	5249.10	6667.80	6121.04	8244.70	7082.20	9646.80	7871.79	9927.50	8001.57	10150.60	8496.05	9719.80	7999.40	9359.30	7478.08
2	Other Income	175.00	153.70	141.10	331.00	284.33	232.70	189.88	306.30	246.88	301.90	252.69	591.20	486.56	204.00	163.00
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	-79.00	-104.80	-96.21	-100.60	-86.42	-170.60	-139.21	-28.90	-23.29	-28.80	-24.11	1.90	1.56	-51.60	-41.23
	Total Output	5345.10	6716.70	6165.93	8475.10	7280.11	9708.90	7922.46	10204.90	8225.15	10423.70	8724.64	10312.90	8487.52	9511.70	7599.85

Appendix 3.19

Revaluation of Output of Lupin Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	4508.50	5384.83	4943.27	7122.51	6118.24	8939.38	7294.53	9752.47	7860.49	11280.07	9441.42	12753.15	10495.84	10088.18	8060.46
2	Other Income	2.96	3.49	3.20	23.31	20.02	415.38	338.95	180.63	145.59	185.64	155.38	88.47	72.81	131.12	104.76
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	-0.51	-132.53	-121.66	-182.44	-156.72	-76.21	-62.19	-170.80	-137.66	-172.72	-144.57	-185.26	-152.47	84.67	67.65
	Total Output	4510.95	5255.79	4824.82	6963.38	5981.54	9278.55	7571.30	9762.30	7868.41	11292.99	9452.23	12656.36	10416.18	10303.97	8232.87

Appendix 3.20

Revaluation of Output of Sun Pharmaceutical Industries Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	3104.07	4015.56	3686.28	2432.14	2089.21	2828.79	2308.29	8017.19	6461.86	7614.46	6373.30	7793.20	6413.80	7947.60	6350.13
2	Other Income	194.17	342.85	314.74	236.17	202.87	159.38	130.05	211.58	170.53	431.82	361.43	515.08	423.91	1128.04	901.30
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	1.99	-81.73	-75.03	-10.53	-9.05	-14.53	-11.86	318.10	256.39	-68.48	-57.32	-167.86	-138.15	159.26	127.25
	Total Output	3300.23	4276.68	3925.99	2657.78	2283.03	2973.64	2426.49	8546.87	6888.78	7977.80	6677.42	8140.42	6699.57	9234.90	7378.69

Appendix 3.21 to 3.24 Revaluation of Output of Refineries Sector Companies

Appendix 3.21

Revaluation of Output of Bharat Petroleum Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	151545.06	211972.97	194591.19	240115.75	206259.43	260060.53	212209.39	238086.90	191898.04	189303.33	158446.89	202210.57	166419.30	236313.10	188814.17
2	Other Income	1754.97	1701.78	1562.23	1680.23	1443.32	1468.66	1198.43	2199.96	1773.17	2012.16	1684.18	2600.68	2140.36	3010.88	2405.69
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	-2056.05	-601.60	-552.27	-1471.79	-1264.27	-2030.30	-1656.72	4513.32	3637.74	724.42	606.34	-5577.61	-4590.37	320.60	256.16
	Total Output	151243.98	213073.15	195601.15	240324.19	206438.48	259498.89	211751.09	244800.18	197308.95	192039.91	160737.40	199233.64	163969.29	239644.58	191476.02

Appendix 3.22

Revaluation of Output of Hindustan Petroleum Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	133671.8	178335.8	163712.28	206722.22	177574.39	223271.3	182189.41	206626.2	166540.70	179571.2	150301.09	187090.5	153975.51	219332.6	175246.75
2	Other Income	1170.66	1025.59	941.49	1102.36	946.93	974.45	795.15	1706.15	1375.16	1138.05	952.55	1448.08	1191.77	1849.46	1477.72
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	-3438.78	-824.29	-756.70	809.45	695.32	-574.43	-468.73	3749.44	3022.05	177.4	148.48	-4454.06	-3665.69	804.54	642.83
	Total Output	131403.70	178537.12	163897.08	208634.03	179216.63	223671.35	182515.82	212081.77	170937.91	180886.64	151402.12	184084.56	151501.59	221986.60	177367.29

Appendix 3.23

Revaluation of Output of Indian Oil Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	328092.30	434508.57	398878.87	447096.25	384055.68	473210.09	386139.43	437524.23	352644.53	350603.09	293454.79	359942.15	296232.39	424038.70	338806.92
2	Other Income	3434.57	3198.02	2935.78	3514.79	3019.20	3417.29	2788.51	4145.95	3341.64	2246.32	1880.17	4200.62	3457.11	3414.62	2728.28
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	-4972.93	-2852.13	-2618.26	-5220.03	-4484.01	-1153	-940.85	8216.07	6622.15	3607.24	3019.26	-15259.8	-12558.82	2327.5	1859.67
	Total Output	326553.94	434854.46	399196.39	445391.01	382590.88	475474.38	387987.09	449886.25	362608.32	356456.65	298354.22	348882.97	287130.68	429780.82	343394.88

Appendix 3.24

Revaluation of Output of Reliance Industries Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Revenue from Operations	248170.00	329904.00	302851.87	360297.00	309495.12	390117.00	318335.47	329076.00	265235.26	233158.00	195153.25	242025.00	199186.58	290042.00	231743.56
2	Other Income	3051.71	6192.00	5684.26	7998.00	6870.28	8936.00	7291.78	8721.00	7029.13	7582.00	6346.13	8709.00	7167.51	8220.00	6567.78
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	-3243.05	-872.00	-800.50	-3317.00	-2849.30	412.00	336.19	1943.00	1566.06	4171.00	3491.13	-4839.00	-3982.50	-3232.00	-2582.37
	Total Output	247978.66	335224.00	307735.63	364978.00	313516.10	399465.00	325963.44	339740.00	273830.44	244911.00	204990.51	245895.00	202371.59	295030.00	235728.97

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Chapter-4

Material Productivity

CHAPTER 4

MATERIAL PRODUCTIVITY

4.1. Introduction

Material is termed as first and foremost factor in production because of the dependence of manufacturing operation on material input. The term material means the commodities consumed during the manufacturing process.

According to Jain, Narang and Agrawal, "Material can be classified as follows:

Raw Materials are the basic materials supplied in crude form to be used for production.

Components are not raw in nature rather are finished parts made out of raw materials which are assembled to make the finished product.

Tools are the appliances used in the manufacturing operations.

Spare Parts are used for the maintenance of plant, machinery and building and for smooth running production schedule.

Consumable Stores are the items used for smooth running of the machines."

Inspite of the above, Material can be classified as the direct or indirect material which is explained as follows:

Direct Material: All materials which are directly attributable to a particular cost unit or product are termed as direct material. It holds the significant portion of the finished goods.

Indirect Material: All materials which are not directly attributable to a particular cost unit or product are termed as indirect material. Although such materials also become the part of finished goods but they are consumed in small quantities and also their allocation to a particular cost unit is difficult to evaluate.

"Material" for the present study includes direct material only as indirect material has been covered under the overheads chapter. Material in the financial statements of the companies under study includes all types of direct material cost incurred directly attributable on the job, product or process, stores and spares consumed and purchases of traded goods.

Performance evaluation of resources in a business concern is largely dependent on material input use. Material productivity indicates that how much has been produced as output by a unit of material input. It measures efficient and effective utilisation of material input. Material productivity is a part of overall productivity of a concern. Material productivity ratio can be calculated as follows:

$$\text{Material Productivity Ratio: } \frac{\text{Total Output}}{\text{Material Input}}$$

Higher ratio indicates efficiency and effectiveness while lower ratio indicates that the material input has not been utilized efficiently. The term "material" in this study includes raw material and components including packing material consumed, stores and spares consumed and purchases of traded goods.

The chapter is based on the research papers published by us in Journals, viz., The Management Accountant, Productivity Journal and International Journal of Research and Analytical Reviews (IJRAR) (Reference No. 8 to 10).

4.2. Measurement of Material Productivity

Measuring the material productivity of any concern is not an easy task. If a concern is engaged in production of variety of goods, it is very difficult to measure the productivity of whole concern because there is difference in the volume of output of individual products. Moreover, it become very difficult also when the value of money does not remain stable due to the fluctuation in the price level. The productivity measured in terms of monetary values may not reveal the correct position unless they are adjusted to the price level changes.

In order to overcome these problems one may either use quantitative data without price changes or index price with quantity. Where the varieties of goods are produced, the difficulty of productivity measurement can be overcome by expressing the output in terms of standard hours. But in these situations it is practically not possible to have the direct figure of the data or the output in terms of standard hours. So it is recommended that the data is to be taken from the published annual reports of the companies thereafter revaluation is done according to the price level changes and also monetary terms of output has been taken.

4.3. Material Control and Improvement Techniques

Physical and accounting control over materials purchase, used in production process and held in stock helps the management in accurately assessing the cost of production. There are chances of material damage in handling and transportation, storing, theft or misappropriation.

According to B. S. Shankara, as quoted by Maheshwari, M. (1998) in her thesis the following measures are being given here to improve the productivity of material.

1. Material productivity can be improved by improving the quality of raw material used in the production process.
2. Improving the technology of raw material processing may also improve the production of finished goods.
3. The equipment used in the production process should be of good quality and efficient design so less number of defective products is produced.
4. There should be improvement in material handling transportation system to avoid wastage of goods in handling and transportation.
5. Proper and effective storage space should be there to avoid losses of goods from storage damages.
6. Proper, collective segregation, efficient recycling of scrap should be done to avoid wastage.
7. EOQ (Economic Order Quantity) system should be followed for ordering the raw material for purchases and also issue it to the production process. It ensures regularity of supply of material and prevents interruption or delay in production.
8. Strict supervision, internal checks and internal audit, beginning from the requisitioning and receipt of material till issued to production process prevents, misappropriation, theft, losses due to handling and transportation, etc.
9. Adequate capital investment in material handling may also results in decreasing the cost of material and ultimately increasing productivity.

4.4. Steps in Measurement of Material Productivity

Following steps are to be taken for the measurement of material productivity:

1. Revaluation of Material Input at Base Year Prices.
2. Computation and Analysis of Material Productivity Ratios and Material Productivity Indices.
3. Testing Hypotheses.
4. Computation of Possible Savings.

4.4.1. Revaluation of Material Input at Base Year Prices

- Revaluation of material input at base year prices for different companies under the study has been carried out in the Appendix 4.1 to 4.24.
- Revalued material input has been calculated for the period of eight years i.e. from 2010-11 to 2017-18. Material input in this study includes raw material and components including packing material consumed, stores and spares consumed and purchases of traded goods.
- Monetary values of the raw material and components, stores and spares and purchases of traded goods for the years covered by the study of different companies of different sectors have been multiplied with the conversion factors. The Wholesale Price Index has been used for revaluing the raw material input.

4.4.2. Computation and Analysis of Material Productivity Ratios and Material Productivity Indices

- Material productivity ratio means output at base year prices per rupee of material input. For calculating this ratio revalued output (Refer Appendix 3.1 to 3.24) has been divided by the revalued input (Refer Appendix 4.1 to 4.24).
- Material productivity indices have been calculated assuming base year material productivity ratio as 100.
- Material productivity index above 100 will indicate the improvement in the productivity as compared to the productivity of the base year while below 100 will mean low productivity as compared to the base year productivity. Material productivity ratios and indices have been calculated in the table 4.1 to 4.24.

4.4.3. Testing Hypotheses

The present study considers two hypotheses for the purpose of analyzing the material productivity ratios and indices.

- **For Intra-company Comparison:** First hypothesis has been developed to measure, analyse and compare the material productivity indices of the sampled companies for the study period.

  Null Hypothesis (H_0): There is no significant difference in the material productivity indices of the sampled company for the study period and can be represented by straight line trend or line of best fit.

  Alternative Hypothesis (H_1): There is a significant difference in the material productivity indices of the sampled company for the study period and cannot be represented by straight line trend or line of best fit.

  The acceptance of null hypothesis would reveal that the material productivity indices of the sampled company for the study period are approximately equal and can be represented by straight line trend or line of best fit. However, rejection of null hypothesis and acceptance of alternative hypothesis would mean that the material productivity indices of the sampled company differ in the study period indicates that indices cannot be represented by straight line trend. Above hypothesis will be tested through chi-square test.

- **For Inter-company Comparison:** Another hypothesis has been develop to study the inter-company relationship i.e. hypothesis developed to measure, analyse and compare the material productivity ratios of sampled companies.

  Null Hypothesis (H_0): There is no significant difference in the material productivity ratios of sampled companies.

  Alternative Hypothesis (H_1): There is a significant difference in the material productivity ratios of sampled companies.

  The acceptance of null hypothesis would reveal that the material productivity ratios of sampled companies are approximately equal. However, rejection of null hypothesis and acceptance of alternative hypothesis would mean that the material productivity ratios between the sampled companies differ. Above inter-company hypothesis is to be tested with the help of Kruskal Wallis One Way Analysis of Variance Test.

4.4.4. Computation of Possible Savings

- The possible savings in material input can be calculated on the basis of following formula:

  Possible Savings in Material Input = Actual material input – Standard material input
- Standard Material Input = minimum requirement of material input per ₹ of output X Actual output revalued according to the base year.
- Actual material input means the actual revalued material input according to base year prices.

4.5. Material Productivity

Material productivity of six sectors included in Nifty 50 has been calculated and analysis has been drawn out of it. These six sectors include Automobile, Energy, Information Technology, Metals, Pharmaceutical and Refineries. Below tables on material productivity shows the raw material and components input output ratio, stores and spares input output ratio, purchase of traded goods input output ratio and total material input output ratio. It also highlighted the Material Productivity Ratios, Material Productivity Indices or Observed Values (O) and Expected Values (E). Thereafter with the help of O and E, Chi-square has been calculated to test the hypothesis.

4.5.1 Material Productivity of Automobile Sector Companies

Material productivity of automobile sector companies has been shown from table 4.1 to 4.4.

Table 4.1

Material Productivity of Bajaj Auto Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	16891.95	18399.35	17881.58	17003.01	17842.32	19807.03	18883.71	21190.96
2	Raw Material and Components (₹ in Crore)	11521.98	12593.89	11836.29	10775.38	11336.87	11740.09	11135.36	12998.40
3	Raw Material and Components (Input Output Ratio)	0.6821	0.6845	0.6619	0.6337	0.6354	0.5927	0.5897	0.6134
4	Stores and Spares (₹ in Crore)	85.00	101.21	106.39	101.98	106.14	110.32	94.34	94.05
5	Stores and Spares (Input Output Ratio)	0.0050	0.0055	0.0059	0.0060	0.0059	0.0056	0.0050	0.0044
6	Purchases of Traded Goods (₹ in Crore)	568.41	689.56	737.73	782.63	930.58	1068.35	1137.77	1119.60
7	Purchases of Traded Goods (Input Output Ratio)	0.0336	0.0375	0.0413	0.0460	0.0522	0.0539	0.0603	0.0528
8	Total Material Input (₹ in Crore)	12,175.39	13,384.66	12,680.41	11,659.99	12,373.59	12,918.76	12,367.47	14,212.05
9	Total Material (Input Output Ratio)	0.7208	0.7275	0.7091	0.6858	0.6935	0.6522	0.6549	0.6707
10	Material Productivity Ratio	1.3874	1.3747	1.4102	1.4582	1.4420	1.5332	1.5269	1.4911
11	Material Productivity Indices/ Observed Indices (O)	100.00	99.08	101.64	105.11	103.93	110.51	110.05	107.47
12	Computed Value /Expected Values (E)	99.20	100.78	102.36	103.94	105.51	107.09	108.67	110.25
13	Chi-Square $(O-E)^2/E$	0.0064	0.0286	0.0050	0.0132	0.0237	0.1090	0.0176	0.0700

Average Material Productivity Indices = 104.73, a = 104.73, b = 0.79, χ^2 = 0.273, S.D. = 4.09, C.V. = 3.91%.

Analysis and Interpretation

Output: The revalued output of Bajaj Auto Ltd. is showing an erratic trend. It is the highest ₹ 21190.96 crore in 2017-18 and it is the lowest ₹ 16891.95 crore in 2010-11.

Raw Material and Components: The most important part of material input is raw material and components. It is ₹ 11521.98 crore in 2010-11, ₹ 12593.89 crore in 2011-12, ₹ 11836.29 crore in 2012-13, ₹ 10775.38 crore in 2013-14, ₹ 11336.87 crore in 2014-15, ₹ 11740.09 crore in 2015-16, ₹ 11135.36 crore in 2016-17 and ₹ 12998.40 crore on 2017-18. Raw material and components input output ratio is the highest 0.6845 in 2011-12 while it is the lowest 0.5897 in 2016-17. The lowest raw material and components input output ratio indicates optimum raw material and components utilisation has been achieved in this year.

Stores and Spares: Another very important part of material input is stores and spares. It is the highest ₹ 110.32 crore in 2015-16 while the lowest ₹ 85.00 crore in 2010-11. Input output ratio of stores and spares is the lowest 0.0044 in 2017-18 as compared to the highest 0.0060 in 2013-14. This indicates stores and spares are optimally utilized in 2017-18.

Purchases of Traded Goods: It is ₹ 568.41 crore in 2010-11, ₹ 689.56 crore in 2011-12, ₹ 737.73 crore in 2012-13, ₹ 782.63 crore in 2013-14, ₹ 930.58 crore in 2014-15, ₹ 1068.35 crore in 2015-16, ₹ 1137.77 crore in 2016-17 and ₹ 1119.60 crore on 2017-18. Input output ratio is the lowest 0.0336 in 2010-11 which indicates optimum utilisation.

Total Material: Total material input is ₹ 12,175.39 crore in 2010-11, ₹ 13,384.66 crore in 2011-12, ₹ 12,680.41 crore in 2012-13, ₹ 11,659.99 crore in 2013-14, ₹ 12,373.59 crore in 2014-15, ₹ 12,918.76 crore in 2015-16, ₹ 12,367.47 crore in 2016-17 and ₹ 14,212.05 crore in 2017-18. Total material input output ratio is the highest 0.7275 in 2011-12 while it is the lowest 0.6522 in 2015-16. The lowest material input output ratio means material has been best utilized in the year 2015-16.

Material Productivity Ratio: There is an erratic trend in the material productivity ratios of Bajaj Auto Ltd. It is 1.3874 in 2010-11, 1.3747 in 2011-12, 1.4102 in 2012-13, 1.4582 in 2013-14, 1.4420 in 2014-15, 1.5332 in 2015-16,

1.5269 in 2016-17 and 1.4911 in 2017-18. Material productivity ratio is the lowest 1.3747 in 2011-12 while it is the highest 1.5332 in 2015-16. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the material input has not been utilized efficiently and mismanagement is responsible for low productivity. Improvement in material efficiency can also be observed from the average of material indices which worked out as 104.73 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: In Bajaj Auto Ltd. the standard deviation calculated is 4.09 and coefficient of variation is 3.91% which highlighted the fact that there is less variation in the data. The computed value of chi-square is 0.273. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This conveys that the material productivity indices of the company for the study period are approximately equal and can be represented by straight line trend or line of best fit.

Table 4.2

Material Productivity of Mahindra & Mahindra Ltd.from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	23692.18	29120.78	35143.67	33416.69	31931.62	34755.61	37410.97	39883.51
2	Raw Material and Components (₹ in Crore)	14708.94	17262.55	17824.14	17650.15	16339.62	16215.33	17389.70	18588.98
3	Raw Material and Components (Input Output Ratio)	0.6208	0.5928	0.5072	0.5282	0.5117	0.4666	0.4648	0.4661
4	Stores and Spares (₹ in Crore)	138.71	148.57	148.37	148.87	144.91	128.10	132.74	143.81
5	Stores and Spares (Input Output Ratio)	0.0059	0.0051	0.0042	0.0045	0.0045	0.0037	0.0035	0.0036
6	Purchases of Traded Goods (₹ in Crore)	1757.23	4858.59	8377.55	6590.77	5931.65	8712.55	8965.46	8528.90
7	Purchases of Traded Goods (Input Output Ratio)	0.0742	0.1668	0.2384	0.1972	0.1858	0.2507	0.2396	0.2138
8	Total Material Input (₹ in Crore)	16,604.88	22,269.71	26,350.06	24,389.79	22,416.18	25,055.98	26,487.90	27,261.69
9	Total Material (Input Output Ratio)	0.7009	0.7647	0.7498	0.7299	0.7020	0.7209	0.7080	0.6835
10	Material Productivity Ratio	1.4268	1.3076	1.3337	1.3701	1.4245	1.3871	1.4124	1.4630
11	Material Productivity Indices/ Observed Indices (O)	100.00	91.65	93.48	96.03	99.84	97.22	98.99	102.53
12	Computed Value /Expected Values (E)	94.57	95.40	96.22	97.05	97.88	98.71	99.53	100.36
13	Chi-Square $(O-E)^2/E$	0.3117	0.1474	0.0786	0.0109	0.0391	0.0225	0.0030	0.0471

Average Material Productivity Indices = 97.47, a = 97.47, b = 0.41, χ^2 = 0.660, S.D. = 3.39, C.V. = 3.48%.

Analysis and Interpretation

Output: The revalued output of Mahindra & Mahindra Ltd. is ₹ 23692.18 crore in 2010-11, ₹ 29120.78 crore in 2011-12, ₹ 35143.67 crore in 2012-13, ₹ 33416.69 crore in 2013-14, ₹ 31931.62 crore in 2014-15, ₹ 34755.61 crore in 2015-16, ₹ 37410.97 crore in 2016-17, ₹ 39883.51 crore in 2017-18.

Raw Material and Components: It is the highest ₹ 18588.98 crore in 2017-18 and the lowest ₹ 14708.94 crore in 2010-11. Raw material and components input output ratio is the highest 0.6208 in 2010-11 while it is the lowest 0.4648 in 2016-17.

Stores and Spares: Stores and spares is the highest ₹ 148.87 crore in 2013-14 crore while it is the lowest ₹ 128.10 crore in 2015-16. Input output ratio of stores and spares is the lowest 0.0035 in 2016-17 as compared to the highest 0.0059 in 2010-11.

Purchases of Traded Goods: It is the lowest ₹ 1757.23 crore in 2010-11 as compared to the highest ₹ 8965.46 crore in 2016-17. Input output ratio is 0.0742 in 2010-11, 0.1668 in 2011-12, 0.2384 in 2012-13, 0.1972 in 2013-14, 0.1858 in 2014-15, 0.2507 in 2015-16, 0.2396 in 2016-17 and 0.2138 in 2017-18. It is the lowest 0.0742 in 2010-11 indicates optimum traded goods have been purchased for the purpose of business.

Total Material: Total material input consumption is having a choppy trend. It is ₹ 16604.88 crore in 2010-11, then it is increased to ₹ 22269.71 crore in 2011-12, then it again increased to ₹ 26350.06 crore in 2012-13, then it decreased to ₹ 24389.79 crore in 2013-14, ₹ 22416.18 crore in 2014-15, increased to ₹ 25055.98 crore in 2015-16, ₹ 26487.90 crore in 2016-17 and ₹ 27261.69 crore in 2017-18. Total material input output ratio is the highest 0.7647 in 2011-12 while it is the lowest 0.6835 in 2017-18. The lowest material input output ratio means total material has been best utilized in the year 2017-18 as compared to other years under study of Mahindra & Mahindra Ltd.

Material Productivity Ratio: Material productivity ratio is 1.4268 in 2010-11, 1.3076 in 2011-12, 1.3337 in 2012-13, 1.3701 in 2013-14, 1.4245 in 2014-15, 1.3871 in 2015-16, 1.4124 in 2016-17 and 1.4630 in 2017-18. Material productivity ratio is the lowest 1.3076 in 2011-12 while it is the highest 1.4630 in 2017-18. The higher ratio indicates efficiency and effectiveness in using material input while the lower ratio indicates that the material input has not been utilized efficiently. Material efficiency can also be observed from the average of material indices which worked out as 97.47 as compared to the base year index of 100.

This indicates that on an average material is not being able to utilize efficiently as compared to the base year.

Testing Hypothesis and Interpretation: Standard deviation of Mahindra & Mahindra Ltd. is 3.39 while its coefficient of variation is 3.48%. The computed value of chi-square of Mahindra & Mahindra Ltd. is 0.660. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the material productivity indices of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 4.3

Material Productivity of Maruti Suzuki India Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	37071.20	33307.52	38159.96	36346.27	40579.12	48726.04	57572.80	65397.27
2	Raw Material and Components (₹ in Crore)	27141.80	24517.03	26069.96	23581.50	26491.45	29886.68	35084.16	35908.10
3	Raw Material and Components (Input Output Ratio)	0.7322	0.7361	0.6832	0.6488	0.6528	0.6134	0.6094	0.5491
4	Stores and Spares (₹ in Crore)	70.20	83.63	160.12	134.40	145.16	179.12	184.43	188.72
5	Stores and Spares (Input Output Ratio)	0.0019	0.0025	0.0042	0.0037	0.0036	0.0037	0.0032	0.0029
6	Purchases of Traded Goods (₹ in Crore)	1278.10	1406.84	1878.12	1984.02	2148.15	2616.80	3688.77	7984.41
7	Purchases of Traded Goods (Input Output Ratio)	0.0345	0.0422	0.0492	0.0546	0.0529	0.0537	0.0641	0.1221
8	Total Material Input (₹ in Crore)	28,490.10	26,007.50	28,108.20	25,699.92	28,784.76	32,682.60	38,957.36	44,081.23
9	Total Material (Input Output Ratio)	0.7685	0.7808	0.7366	0.7071	0.7093	0.6707	0.6767	0.6741
10	Material Productivity Ratio	1.3012	1.2807	1.3576	1.4143	1.4097	1.4909	1.4778	1.4836
11	Material Productivity Indices/ Observed Indices (O)	100.00	98.42	104.34	108.69	108.34	114.58	113.58	114.02
12	Computed Value /Expected Values (E)	99.23	101.67	104.10	106.53	108.96	111.39	113.82	116.26
13	Chi-Square $(O-E)^2/E$	0.0059	0.1034	0.0005	0.0438	0.0035	0.0911	0.0005	0.0432

Average Material Productivity Indices= 107.74, a = 107.74, b = 1.22, χ^2 = 0.292, S.D. = 5.91, C.V = 5.49 %.

Analysis and Interpretation

Output: The output of Maruti Suzuki India Ltd. is displaying a fluctuating trend. It is the highest ₹ 65397.27 crore in 2017-18 and it is the lowest ₹ 33307.52 crore in 2011-12.

Raw Material and Components: The important factor that can be analysed in material input is raw material and components. It is ₹ 27141.80 crore in 2010-11, ₹ 24517.03 crore in 2011-12, ₹ 26069.96 crore in 2012-13, ₹ 23581.50 crore in 2013-14, ₹ 26491.45 crore in 2014-15, ₹ 29886.68 crore in 2015-16, ₹ 35084.16 crore in 2016-17 and ₹ 35908.10 crore in 2017-18. It is the highest ₹ 35908.10 crore in 2017-18 while it is the lowest 23581.50 in 2013-14. Raw material and

components input output ratio is the highest 0.7361 in 2011-12 while it is the lowest 0.5491 in 2017-18. The lowest raw material and components input output ratio indicates raw material and components has been utilised optimally in this year.

Stores and Spares: Another important factor is stores and spares. Stores and spares consumption is the highest ₹ 188.72 crore in 2017-18 while it is the lowest ₹ 70.20 crore in 2010-11. Input output ratio of stores and spares is the lowest 0.0019 in 2010-11 as compared to the highest 0.0042 in 2012-13. This indicates stores and spares in optimally utilized in 2010-11.

Purchases of Traded Goods: The traded goods purchased are displaying an upward trend. It is the highest ₹ 7984.41 crore in 2017-18 while it is the lowest ₹ 1278.10 crore in 2010-11. Input output ratio is also having an increasing trend. It is the lowest 0.0345 in 2010-11 and it is the highest 0.1221 in 2017-18.

Total Material: Total material input of Maruti Suzuki India Ltd. is ₹ 28,490.10 crore in 2010-11, ₹ 26,007.50 crore in 2011-12, ₹ 28,108.20 crore in 2012-13, ₹ 25,699.92 crore in 2013-14, ₹ 28,784.76 crore in 2014-15, ₹ 32,682.60 crore in 2015-16, ₹ 38,957.36 crore in 2016-17 and ₹ 44,081.23 crore in 2017-18. Total material input output ratio 0.7808 is the highest in 2011-12 while 0.6707 is the lowest in 2015-16. The lowest material input output ratio means material has been best utilized in the year 2015-16.

Material Productivity Ratio: Material productivity ratio of Maruti Suzuki India Ltd. is 1.3012 in 2010-11, 1.2807 in 2011-12, 1.3576 in 2012-13, 1.4143 in 2013-14, 1.4097 in 2014-15, 1.4909 in 2015-16, 1.4778 in 2016-17 and 1.4836 in 2017-18. It is the lowest 1.2807 in 2011-12 while it is the highest 1.4909 in 2015-16. Improvement in material efficiency can also be observed from the average of material indices which is 107.74 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Maruti Suzuki India Ltd. is 5.91 with 5.49% of variability. In Maruti Suzuki India Ltd. the computed value of chi-square is 0.292. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This displays that the material

productivity indices of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 4.4

Material Productivity of Tata Motors Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	47157.19	49807.74	40124.16	31410.17	30067.20	37267.99	37072.17	48923.62
2	Raw Material and Components (₹ in Crore)	27058.47	31115.44	23402.84	16722.18	17857.12	20350.05	22757.31	29627.28
3	Raw Material and Components (Input Output Ratio)	0.5738	0.6247	0.5833	0.5324	0.5939	0.5460	0.6139	0.6056
4	Stores and Spares (₹ in Crore)	625.45	691.27	563.22	406.29	360.57	394.18	537.92	510.84
5	Stores and Spares (Input Output Ratio)	0.0133	0.0139	0.0140	0.0129	0.0120	0.0106	0.0145	0.0104
6	Purchases of Traded Goods (₹ in Crore)	7363.13	5906.37	5037.56	4120.65	4646.78	4402.01	3247.53	3805.17
7	Purchases of Traded Goods (Input Output Ratio)	0.1561	0.1186	0.1255	0.1312	0.1545	0.1181	0.0876	0.0778
8	Total Material Input (₹ in Crore)	35,047.05	37,713.08	29,003.62	21,249.12	22,864.47	25,146.23	26,542.76	33,943.29
9	Total Material (Input Output Ratio)	0.7432	0.7572	0.7228	0.6765	0.7604	0.6747	0.7160	0.6938
10	Material Productivity Ratio	1.3455	1.3207	1.3834	1.4782	1.3150	1.4821	1.3967	1.4413
11	Material Productivity Indices/ Observed Indices (O)	100.00	98.15	102.82	109.86	97.73	110.15	103.80	107.12
12	Computed Value /Expected Values (E)	100.04	101.09	102.13	103.18	104.23	105.27	106.32	107.37
13	Chi-Square $(O-E)^2/E$	0.0000	0.0850	0.0046	0.4323	0.4047	0.2255	0.0597	0.0006

Average Material Productivity Indices= 103.70, a = 103.70, b = 0.52, χ^2 = 1.212, S.D. = 4.64, C.V. = 4.47%.

Analysis and Interpretation

Output: The revalued output of Tata Motors Ltd. is the highest ₹ 49807.74 crore in 2011-12 while it is the lowest in ₹ 30067.20 crore in 2014-15.

Raw Material and Components: It is the highest ₹ 31115.44 crore in 2011-12 and the lowest ₹ 16722.18 crore in 2013-14. Raw materials and components input output ratio is 0.5738 in 2010-11, 0.6247 in 2011-12, 0.5833 in 2012-13, 0.5324 in 2013-14, 0.5939 in 2014-15, 0.5460 in 2015-16, 0.6139 in 2016-17 and 0.6056 in 2017-18. It is the highest 0.6247 in 2011-12 while it is the lowest 0.5324 in 2013-14.

Stores and Spares: Stores and spares consumption is the highest ₹ 691.27 crore in 2011-12 while it is the lowest ₹ 360.57 crore in 2014-15. Input output ratio of stores and spares is the highest 0.0145 in 2016-17 as compared to the lowest 0.0104 in 2017-18.

Purchases of Traded Goods: It is the lowest ₹ 3247.53 crore in 2016-17 as compared to ₹ 7363.13 crore in 2010-11. Input output ratio is the lowest 0.0778 in 2017-18 indicates less traded goods purchased for the purpose of business. It is the highest 0.1561 in 2010-11.

Total Material: Total material input consumption is ₹ 35,047.05 crore in 2010-11, then it is increased to ₹ 37,713.08 crore in 2011-12, then it decreased to ₹

29,003.62 crore in 2012-13, then again it decreased to ₹ 21,249.12 crore in 2013-14, then it slightly increased to ₹ 22,864.47 crore in 2014-15, again increased to ₹ 25,146.23 crore in 2015-16, ₹ 26,542.76 crore in 2016-17 and lastly it reached to ₹ 33,943.29 crore in 2017-18. Total material input output ratio is the highest 0.7604 in 2014-15 while it is the lowest 0.6747 in 2015-16. The lowest material input output ratio means total material is best utilized in the year 2015-16 as compared to other years under study of Tata Motors Ltd.

Material Productivity Ratio: Material productivity ratio is 1.3455 in 2010-11, 1.3207 in 2011-12, 1.3834 in 2012-13, 1.4782 in 2013-14, 1.3150 in 2014-15, 1.4821 in 2015-16, 1.3967 in 2016-17 and 1.4413 in 2017-18. Material productivity ratio is the lowest 1.3150 in 2014-15 while it is the highest 1.4821 in 2015-16. The higher the ratio indicates efficiency and effectiveness while the lower the ratio indicates under utilisation of material input. Material efficiency can also be analysed from the average of material indices. It is 103.70 which is higher than the base year index of 100. This indicates that on an average material is utilized efficiently in all the years.

Testing Hypothesis and Interpretation: The standard deviation of Tata Motors Ltd. is 4.64 with coefficient of variation 4.47%. The computed value of chi-square of Tata Motors Ltd. is 1.212. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the material productivity indices of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

4.5.2. Material Productivity of Energy Sector Companies

Material productivity of energy sector companies has been shown from table 4.5 to 4.8.

Table 4.5

Material Productivity of GAIL (India) Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	32844.73	37024.85	41429.76	47148.15	46615.02	44514.51	40629.38	43636.95
2	Raw Material and Components (₹ in Crore)	2178.78	2289.58	2550.10	3952.24	4009.03	2791.53	2593.47	2966.22
3	Raw Material and Components (Input Output Ratio)	0.0663	0.0618	0.0616	0.0838	0.0860	0.0627	0.0638	0.0680
4	Stores and Spares (₹ in Crore)	238.38	246.15	255.42	281.98	247.15	257.74	282.65	296.01
5	Stores and Spares (Input Output Ratio)	0.0073	0.0066	0.0062	0.0060	0.0053	0.0058	0.0070	0.0068
6	Purchases of Traded Goods (₹ in Crore)	21576.97	26108.34	28687.93	33647.29	32520.75	32180.95	27323.33	29370.11
7	Purchases of Traded Goods (Input Output Ratio)	0.6569	0.7052	0.6924	0.7137	0.6976	0.7229	0.6725	0.6731
8	Total Material Input (₹ in Crore)	23,994.13	28,644.08	31,493.44	37,881.50	36,776.93	35,230.22	30,199.45	32,632.33
9	Total Material (Input Output Ratio)	0.7305	0.7736	0.7602	0.8035	0.7890	0.7914	0.7433	0.7478
10	Material Productivity Ratio	1.3689	1.2926	1.3155	1.2446	1.2675	1.2635	1.3454	1.3372
11	Material Productivity Indices/ Observed Indices (O)	100.00	94.43	96.10	90.92	92.60	92.31	98.28	97.69
12	Computed Value /Expected Values (E)	95.57	95.49	95.41	95.33	95.25	95.17	95.09	95.02
13	Chi-Square $(O-E)^2/E$	0.2057	0.0118	0.0050	0.2037	0.0741	0.0864	0.1070	0.0752

Average Material Productivity Indices = 95.29, a = 95.29, b = -0.04, χ^2 = 0.769, S.D. = 3.03, C.V. = 3.18 %.

Analysis and Interpretation

Output: The revalued output of GAIL (India) Ltd. is depicting the changing trend. It is ₹ 32844.73 crore in 2010-11, then it increased to ₹ 37024.85 crore in 2011-12, then again it increased to ₹ 41429.76 crore in 2012-13 and lastly it reached to ₹ 47148.15 crore in 2013-14 then it started declining and reached to ₹ 46615.02 crore in 2014-15, then it again it decreased to ₹ 44514.51 crore in 2015-16 and lastly it reached to ₹ 40629.38 crore in 2016-17, then in 2017-18 it increased slightly and reached to ₹ 43636.95 crore.

Raw Material and Components: The most important chunk of total material input is raw material and components. Raw material and components consumption is highlighting the choppy trend. It is ₹ 2178.78 crore in 2010-11, ₹ 2289.58 crore in 2011-12, ₹ 2550.10 crore in 2012-13, ₹ 3952.24 crore in 2013-14, ₹ 4009.03 crore in 2014-15, ₹ 2791.53 crore in 2015-16, ₹ 2593.47 crore in 2016-17 and ₹ 2966.22 crore on 2017-18. Raw material and components input output ratio is the highest 0.0860 in 2014-15 while it is the lowest 0.0616 in 2012-13. The lowest raw material and components input output ratio indicates raw material and components has been utilised optimally in this year.

Stores and Spares: The very important share of total material input is stores and spares. Stores and spares is the highest ₹ 296.01 crore in 2017-18 while it is the lowest ₹ 238.38 crore in 2010-11. Input output ratio of stores and spares is the

lowest 0.0053 in 2014-15 as compared to the highest 0.0073 in 2010-11. This indicates stores and spares in optimally utilized in 2014-15.

Purchases of Traded Goods: It is the highest ₹ 33647.29 crore in 2013-14 while it is the lowest ₹ 21576.97 crore in 2010-11. Input output ratio is the lowest 0.6569 in 2010-11 indicates optimum utilisation.

Total Material: Total material input is ₹ 23994.13 crore in 2010-11, ₹ 28644.08 crore in 2011-12, ₹ 31493.44 crore in 2012-13, ₹ 37881.50 crore in 2013-14, ₹ 36776.93 crore in 2014-15, ₹ 35230.22 crore in 2015-16, ₹ 30199.45 crore in 2016-17 and ₹ 32632.33 crore in 2017-18. Total material input output ratio is the highest 0.8035 in 2013-14 while it is the lowest 0.7305 in 2010-11. The lowest material input output ratio means material has been best utilized in the year 2010-11.

Material Productivity Ratio: There is an inconsistent trend in the material productivity ratios. Material productivity ratio is 1.3689 in 2010-11, 1.2926 in 2011-12, 1.3155 in 2012-13, 1.2446 in 2013-14, 1.2675 in 2014-15, 1.2635 in 2015-16, 1.3454 in 2016-17 and 1.3372 in 2017-18. Material productivity ratio is the lowest 1.2446 in 2013-14 while it is the highest 1.3689 in 2010-11. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the material input has not been utilized efficiently. Material efficiency can also be observed from the average of material indices which worked out as 95.29 as compared to the base year index of 100. This indicates that material is not been able to utilize efficiently as compared to the base year.

Testing Hypothesis and Interpretation: In GAIL (India) Ltd. the standard deviation calculated is 3.03 and its coefficient of variation is 3.18% which shows that there is less variation in the data. The computed value of chi-square is 0.769. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the material productivity indices of the company for the study period are approximately equal and can be represented by straight line trend or line of best fit.

Table 4.6

Material Productivity of NTPC Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	57407.30	59514.54	59078.16	60961.58	60721.91	60009.61	65298.71	68081.15
2	Raw Material and Components (₹ in Crore)	35373.78	38221.35	35234.68	37397.04	39359.86	36654.95	39151.91	38604.06
3	Raw Material and Components (Input Output Ratio)	0.6162	0.6422	0.5964	0.6135	0.6482	0.6108	0.5996	0.5670
4	Stores and Spares (₹ in Crore)	31.33	41.53	39.81	38.84	38.96	45.11	47.31	58.81
5	Stores and Spares (Input Output Ratio)	0.0005	0.0007	0.0007	0.0006	0.0006	0.0008	0.0007	0.0009
6	Purchases of Traded Goods (₹ in Crore)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1049.49
7	Purchases of Traded Goods (Input Output Ratio)	-	-	-	-	-	-	-	0.0154
8	Total Material Input (₹ in Crore)	35,405.11	38,262.88	35,274.49	37,435.88	39,398.82	36,700.06	39,199.22	39,712.37
9	Total Material (Input Output Ratio)	0.6167	0.6429	0.5971	0.6141	0.6488	0.6116	0.6003	0.5833
10	Material Productivity Ratio	1.6214	1.5554	1.6748	1.6284	1.5412	1.6351	1.6658	1.7144
11	Material Productivity Indices/ Observed Indices (O)	100.00	95.93	103.29	100.43	95.05	100.84	102.74	105.73
12	Computed Value /Expected Values (E)	97.94	98.67	99.40	100.14	100.87	101.60	102.33	103.06
13	Chi-Square $(O-E)^2/E$	0.0433	0.0764	0.1520	0.0009	0.3353	0.0056	0.0016	0.0691

Average Material Productivity Indices= 100.50, a = 100.50, b = 0.37, χ^2 = 0.684, S.D. = 3.37, C.V. = 3.36%.

Analysis and Interpretation

Output: The revalued output of NTPC Ltd. is ₹ 57407.30 crore in 2010-11, ₹ 59514.54 crore in 2011-12, ₹ 59078.16 crore in 2012-13, ₹ 60961.58 crore in 2013-14, ₹ 60721.91 crore in 2014-15, ₹ 60009.61 crore in 2015-16, ₹ 65298.71 crore in 2016-17, ₹ 68081.15 crore in 2017-18.

Raw Material and Components: It is the highest ₹ 39359.86 crore in 2014-15 and the lowest ₹ 35234.68 crore in 2012-13. Raw material and components input output ratio is the highest 0.6482 in 2014-15 while it is the lowest 0.5670 in 2017-18.

Stores and Spares: Stores and spares consumption is the highest ₹ 58.81 crore in 2017-18 while it is the lowest ₹ 31.33 crore in 2010-11. Input output ratio of stores and spares is the lowest 0.0005 in 2010-11 as compared to the highest 0.0009 in 2017-18.

Purchases of Traded Goods: It is ₹ 1049.49 crore in 2017-18 and its input output ratio is 0.0154.

Total Material: Total material input consumption highlights an inconstant trend. It is ₹ 35405.11 crore in 2010-11, ₹ 38262.88 crore in 2011-12, ₹ 35274.49 crore in 2012-13, ₹ 37435.88 crore in 2013-14, ₹ 39398.82 crore in 2014-15, ₹ 36700.06 crore in 2015-16, ₹ 39199.22 crore in 2016-17 and ₹ 39712.37 crore in 2017-18. Total material input output ratio is the highest 0.6488 in 2014-15 while it is the lowest 0.5833 in 2017-18. The lowest material input output ratio means total

material has been best utilized in the year 2017-18 as compared to other years under study of NTPC Ltd.

Material Productivity Ratio: Material productivity ratio is 1.6214 in 2010-11, 1.5554 in 2011-12, 1.6748 in 2012-13, 1.6284 in 2013-14, 1.5412 in 2014-15, 1.6351 in 2015-16, 1.6658 in 2016-17 and 1.7144 in 2017-18. Material productivity ratio is the lowest 1.5412 in 2014-15 while it is the highest 1.7144 in 2017-18. The highest ratio indicates efficiency in utilizing material input while the lowest ratio indicates inefficiency in utilisation of material input. Improvement in material efficiency can also be observed from the average of material indices which worked out as 100.50 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: Standard deviation of NTPC Ltd. is 3.37 while its coefficient of variation is 3.36%. The computed value of chi-square of NTPC Ltd. is 0.684. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the material productivity indices of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 4.7

Material Productivity of Oil and Natural Gas Corporation Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	71732.86	74244.84	75951.96	74017.52	70984.50	70792.55	70326.36	74166.87
2	Raw Material and Components (₹ in Crore)	2776.85	2247.72	3604.41	4181.72	3991.84	4426.39	5012.29	4487.08
3	Raw Material and Components (Input Output Ratio)	0.0387	0.0303	0.0475	0.0565	0.0562	0.0625	0.0713	0.0605
4	Stores and Spares (₹ in Crore)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	Stores and Spares (Input Output Ratio)	-	-	-	-	-	-	-	-
6	Purchases of Traded Goods (₹ in Crore)	13.83	2.28	2.66	2.59	3.55	5.98	2.14	0.00
7	Purchases of Traded Goods (Input Output Ratio)	0.0002	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	-
8	Total Material Input (₹ in Crore)	2,790.68	2,250.00	3,607.07	4,184.32	3,995.40	4,432.38	5,014.43	4,487.08
9	Total Material (Input Output Ratio)	0.0389	0.0303	0.0475	0.0565	0.0563	0.0626	0.0713	0.0605
10	Material Productivity Ratio	25.7044	32.9977	21.0564	17.6893	17.7666	15.9717	14.0248	16.5290
11	Material Productivity Indices/ Observed Indices (O)	100.00	128.3736	81.92	68.82	69.12	62.14	54.56	64.30
12	Computed Value /Expected Values (E)	106.90	98.83	90.76	82.69	74.62	66.55	58.48	50.40
13	Chi-Square $(O-E)^2/E$	0.4457	8.8305	0.8616	2.3269	0.4053	0.2924	0.2620	3.8328

Average Material Productivity Indices= 78.65, a= 78.65, b= -4.04, χ^2= 17.257, S.D. = 22.87, C.V. = 29.08%.

Analysis and Interpretation

Output: The output of Oil and Natural Gas Corporation Ltd. is portraying the changing trend. It is the highest ₹ 75951.96 crore in 2012-13 and it is the lowest ₹ 70326.36 crore in 2016-17.

Raw Material and Components: The important part to analyse in material input is raw material and components. It is the highest ₹ 5012.29 crore in 2016-17 while it is the lowest ₹ 2247.72 crore in 2011-12. Raw material and components input output ratio is the highest 0.0713 in 2016-17 while it is the lowest 0.0303 in 2011-12. The lowest raw material and components input output ratio indicates optimum raw material and components utilisation has been achieved in this year.

Stores and Spares: There is no consumption of stores and spares in Oil and Natural Gas Corporation Ltd.

Purchases of Traded Goods: The traded goods purchased is the highest ₹ 13.83 crore in 2010-11 while it is the lowest ₹ 2.14 crore in 2016-17 while there is no purchases of traded goods in 2017-18.

Total Material: Total material input of Oil and Natural Gas Corporation Ltd. is ₹ 2790.68 crore in 2010-11, ₹ 2250.00 crore in 2011-12, ₹ 3607.07 crore in 2012-13, ₹ 4184.32 crore in 2013-14, ₹ 3995.40 crore in 2014-15, ₹ 4432.38 crore in 2015-16, ₹ 5014.43 crore in 2016-17 and ₹ 4487.08 crore in 2017-18. Total material input output ratio is the highest 0.0713 in 2016-17 while it is the lowest 0.0303 in 2011-12. The lowest material input output ratio means material has been best utilized in the year 2011-12.

Material Productivity Ratio: Material productivity ratio of Oil and Natural Gas Corporation Ltd. is 25.7044 in 2010-11, 32.9977 in 2011-12, 21.0564 in 2012-13, 17.6893 in 2013-14, 17.7666 in 2014-15, 15.9717 in 2015-16, 14.0248 in 2016-17 and 16.5290 in 2017-18. It is the lowest 14.0248 in 2016-17 while it is the highest 32.9977 in 2011-12. Material efficiency can also be observed from the average of material indices which worked out as 78.65 as compared to the base year index of 100. This indicates that material is not being utilized efficiently as compared to the base year.

Testing Hypothesis and Interpretation: The standard deviation of Oil and Natural Gas Corporation Ltd. is 22.87 with 29.08% of variability. In Oil and Natural Gas Corporation Ltd. the computed value of chi-square is 17.257. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected and alternative hypothesis is

accepted. This manifests that the material productivity indices of the company for the study period are not same and cannot be represented by straight line trend or line of best fit.

Table 4.8

Material Productivity of Power Grid Corporation of India Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	9098.75	9900.64	11449.39	12828.67	14330.71	17812.35	21872.62	24582.29
2	Raw Material and Components (₹ in Crore)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Raw Material and Components (Input Output Ratio)	-	-	-	-	-	-	-	-
4	Stores and Spares (₹ in Crore)	0.03	0.05	0.08	0.05	0.82	3.84	3.23	6.93
5	Stores and Spares (Input Output Ratio)	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002	0.0001	0.0003
6	Purchases of Traded Goods (₹ in Crore)	0.00	0.00	54.55	179.03	0.00	0.00	0.00	0.00
7	Purchases of Traded Goods (Input Output Ratio)	-	-	0.0048	0.0140	-	-	-	-
8	Total Material Input (₹ in Crore)	0.03	0.05	54.62	179.08	0.82	3.84	3.23	6.93
9	Total Material (Input Output Ratio)	0.0000	0.0000	0.0048	0.0140	0.0001	0.0002	0.0001	0.0003
10	Material Productivity Ratio	303,291.67	215,700.20	209.60	71.64	17,431.41	4,636.42	6,779.77	3,548.60
11	Material Productivity Indices/ Observed Indices (O)	100.00	71.12	0.07	0.02	5.75	1.53	2.24	1.17
12	Computed Value /Expected Values (E)	65.49	53.28	41.06	28.84	16.63	4.41	-7.80	-20.02
13	Chi-Square $(O-E)^2/E$	18.1822	5.9762	40.9224	28.7974	7.1205	1.8852	(12.9140)	(22.4271)

Average Material Productivity Indices= 22.74, a= 22.74, b= -6.11, χ^2= 67.543, S.D. = 37.02, C.V. = 162.82%.

Analysis and Interpretation

Power Grid Corporation of India Ltd. is the company engaged in transmission of electricity. So the revenue generated and all the other expenses in the financial statement of the company are related to the transmission only. Due to this raw material and components element is not there in its financial statement. Stores and spares includes transmission inventory such as towers, conductors and other line materials. Its consumption of material is also very minute as compared to output. Due to this material productivity ratio is facing very high fluctuations. So, to make the analysis more realistic, it has been decided to exclude it in further analysis of material productivity.

Testing Hypothesis and Interpretation: The standard deviation of Power Grid Corporation of India Ltd. is 37.02 with 162.82% of variability indicating unrealistic picture. The computed value of chi-square is 67.543 while its table value at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected and alternative hypothesis is accepted.

4.5.3. Material Productivity of Information Technology Sector Companies

Material productivity of information technology sector companies has been shown from table 4.9 to 4.12.

Table 4.9

Material Productivity of Infosys Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	26532.00	30814.51	33555.12	38284.27	40813.42	47702.30	51314.87	52702.04
2	Raw Material and Components (₹ in Crore)	459.00	573.75	630.51	750.72	789.07	878.01	1016.41	1014.73
3	Raw Material and Components (Input Output Ratio)	0.0173	0.0186	0.0188	0.0196	0.0193	0.0184	0.0198	0.0193
4	Stores and Spares (₹ in Crore)	23.00	22.03	18.90	17.14	31.43	23.44	25.51	17.58
5	Stores and Spares (Input Output Ratio)	0.0009	0.0007	0.0006	0.0004	0.0008	0.0005	0.0005	0.0003
6	Purchases of Traded Goods (₹ in Crore)	-	-	-	-	-	-	-	-
7	Purchases of Traded Goods (Input Output Ratio)	-	-	-	-	-	-	-	-
8	Total Material Input (₹ in Crore)	482.00	595.78	649.40	767.86	820.51	901.45	1,041.92	1,032.31
9	Total Material (Input Output Ratio)	0.0182	0.0193	0.0194	0.0201	0.0201	0.0189	0.0203	0.0196
10	Material Productivity Ratio	55.0456	51.7211	51.6706	49.8587	49.7417	52.9174	49.2504	51.0526
11	Material Productivity Indices/ Observed Indices (O)	100.00	93.96	93.87	90.58	90.36	96.13	89.47	92.75
12	Computed Value /Expected Values (E)	96.17	95.37	94.58	93.79	92.99	92.20	91.41	90.61
13	Chi-Square $(O-E)^2/E$	0.1528	0.0209	0.0054	0.1099	0.0743	0.1678	0.0410	0.0502

Average Material Productivity Indices = 93.39, a = 93.39, b = - 0.40, χ^2 = 0.622, S.D. = 3.25, C.V. = 3.48 %.

Analysis and Interpretation

Output: The revalued output of Infosys Ltd. has an increasing trend. It is the highest ₹ 52702.04 crore in 2017-18 and it is the lowest ₹ 26532.00 crore in 2010-11.

Raw Material and Components: It is ₹ 459.00 crore in 2010-11 and reached to ₹ 1014.73 crore in 2017-18. Its input output ratio is the highest 0.0198 in 2016-17 while it is the lowest 0.0173 in 2010-11. The lowest raw material and components input output ratio indicates optimum raw material and components utilisation has been achieved in this year.

Stores and Spares: It portrays a changeable trend. It is the lowest ₹ 17.14 crore and the highest ₹ 31.43 crore. The input output ratio of stores and spares of Infosys Ltd. is the lowest 0.0003 in 2017-18 as compared to the highest 0.0009 in 2010-11.

Purchases of Traded Goods: This section of material input is not there in Infosys Ltd.

Total Material: Total material input is showing an increasing trend except in the year 2017-18. Its input output ratio is the lowest in the year 2010-11 with 0.0182.

This means material is the best utilized in the year 2010-11. It is the highest 0.0203 in 2016-17.

Material Productivity Ratio: It is 55.0456 in 2010-11 then decreased and reached to 49.7417 in 2014-15 and increased to 52.9174 in 2015-16 then decreased in the year 2016-17 and then increased and reached to 51.0526 in 2017-18. Material productivity ratio is the best 55.0456 in 2010-11. Improvement in material efficiency can also be observed from the average of material indices which worked out to 93.39 as compared to the base year index of 100. This means that there is no improvement in material efficiency.

Testing Hypothesis and Interpretation: The standard deviation is 3.25 with 3.48% of variability. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Infosys Ltd. is 0.622. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This depicts that the material productivity indices of the Infosys Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 4.10

Material Productivity of Tata Consultancy Services Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	29771.01	38137.37	43513.96	55314.66	62904.22	74998.91	80044.98	82424.84
2	Raw Material and Components (₹ in Crore)	17.71	10.81	21.49	32.45	52.08	32.72	78.19	67.92
3	Raw Material and Components (Input Output Ratio)	0.0006	0.0003	0.0005	0.0006	0.0008	0.0004	0.0010	0.0008
4	Stores and Spares (₹ in Crore)	0.04	0.03	0.02	0.02	0.05	0.62	0.00	0.00
5	Stores and Spares (Input Output Ratio)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-	-
6	Purchases of Traded Goods (₹ in Crore)	0.00	0.00	0.00	0.00	0.00	0.00	1369.47	1534.08
7	Purchases of Traded Goods (Input Output Ratio)	-	-	-	-	-	-	0.0171	0.0186
8	Total Material Input (₹ in Crore)	17.75	10.84	21.51	32.47	52.13	33.34	1,447.66	1,602.00
9	Total Material (Input Output Ratio)	0.0006	0.0003	0.0005	0.0006	0.0008	0.0004	0.0181	0.0194
10	Material Productivity Ratio	1,677.2400	3,517.6952	2,023.0244	1,703.6333	1,206.6317	2,249.6719	55.2928	51.4514
11	Material Productivity Indices/ Observed Indices (O)	100.00	209.73	120.62	101.57	71.94	134.13	3.30	3.07
12	Computed Value /Expected Values (E)	163.87	143.63	123.40	103.16	82.93	62.69	42.46	22.22
13	Chi-Square $(O-E)^2/E$	24.8935	30.4169	0.0627	0.0245	1.4552	81.4060	36.1182	16.5081

Average Material Productivity Indices=93.04, a=93.04, b= -10.12, χ^2= 190.885, S.D.= 64.01, C.V.= 68.80%.

Analysis and Interpretation

Output: The revalued output of Tata Consultancy Services Ltd. for the year 2010-11 is ₹ 29771.01 crore and reached to ₹ 82424.84 crore in 2017-18.

Raw Material and Components: The raw material and components section of material input is the minimum ₹ 10.81 crore in 2011-12 and the maximum ₹ 78.19 crore in 2016-17. Raw material and components input output ratio is the highest 0.0010 in 2016-17 while it is the lowest 0.0003 in 2011-12 indicates that raw material and components are optimally utilized in year 2011-12.

Stores and Spares: Stores and spares consumption is very much insignificant hence ignored in calculation.

Purchases of Traded Goods: It is available for 2 years only. It is ₹ 1369.47 crore having input output ratio 0.0171 in 2016-17 and ₹ 1534.08 crore having input output ratio 0.0186 in 2017-18.

Total Material: Total material input is the minimum ₹ 10.84 crore in 2011-12 as compared to the maximum ₹ 1602.00 crore in 2017-18. Its input output ratio is the minimum 0.0003 in 2011-12 and the maximum 0.0194 in 2017-18.

Material Productivity Ratio: It is 1677.2400 in 2010-11 while it is 51.4514 in 2017-18. Material productivity ratio is the lowest 51.4514 in 2017-18 while it is the highest 3517.6952 in 2011-12. Improvement in material efficiency can also be observed from the average of material indices which is 93.04 as compared to the base year.

Testing Hypothesis and Interpretation: The standard deviation of Tata Consultancy Services Ltd. is 64.01 with 68.80% of variability. For testing the hypothesis chi-square method has been used. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Tata Consultancy Services Ltd. is 190.885. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected. This describe that the material productivity ratios of the Tata Consultancy Services Ltd. for the eight year period are not same and cannot be represented by straight line trend or line of best fit.

Table 4.11

Material Productivity of Tech Mahindra Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	5092.10	4875.22	5073.86	13354.17	15545.48	18479.45	19799.98	20288.13
2	Raw Material and Components (₹ in Crore)	1.50	0.46	0.00	0.00	0.00	0.00	0.00	0.00
3	Raw Material and Components (Input Output Ratio)	0.0003	0.0001	-	-	-	-	-	-
4	Stores and Spares (₹ in Crore)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	Stores and Spares (Input Output Ratio)	-	-	-	-	-	-	-	-
6	Purchases of Traded Goods (₹ in Crore)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	Purchases of Traded Goods (Input Output Ratio)	-	-	-	-	-	-	-	-
8	Total Material Input (₹ in Crore)	1.50	0.46	-	-	-	-	-	-
9	Total Material (Input Output Ratio)	0.0003	0.0001	-	-	-	-	-	-
10	Material Productivity Ratio	3,394.7333	10,598.3100	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
11	Material Productivity Indices/ Observed Indices (O)	100.00	312.20	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
12	Computed Value /Expected Values (E)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
13	Chi-Square $(O-E)^2/E$	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Tech Mahindra Ltd. is specialist in digital transformation, consulting and business re-engineering solutions. So material input is not there in its financial statements, due to this material productivity and chi-square value has not been possible to calculate.

Table 4.12

Material Productivity of Wipro Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (Rs in Crore)	26949.60	30252.87	29664.36	32941.35	35024.33	39676.31	40209.89	37750.59
2	Raw Material and Components (Rs in Crore)	1085.70	1328.81	304.26	167.52	2.74	0.17	0.00	0.00
3	Raw Material and Components (Input Output Ratio)	0.0403	0.0439	0.0103	0.0051	0.0001	0.0000	-	-
4	Stores and Spares (Rs in Crore)	22.70	26.44	0.00	46.84	-2.26	-1.00	0.00	0.00
5	Stores and Spares (Input Output Ratio)	0.0008	0.0009	-	0.0014	(0.0001)	(0.0000)	-	-
6	Purchases of Traded Goods (Rs in Crore)	2697.20	2945.49	2016.24	1865.21	2253.90	2222.65	1799.82	1174.21
7	Purchases of Traded Goods (Input Output Ratio)	0.1001	0.0974	0.0680	0.0566	0.0644	0.0560	0.0448	0.0311
8	Total Material Input (Rs in Crore)	3,805.60	4,300.74	2,320.50	2,079.58	2,254.38	2,221.82	1,799.82	1,174.21
9	Total Material (Input Output Ratio)	0.1412	0.1422	0.0782	0.0631	0.0644	0.0560	0.0448	0.0311
10	Material Productivity Ratio	7.0816	7.0343	12.7836	15.8404	15.5361	17.8576	22.3411	32.1498
11	Material Productivity Indices/ Observed Indices (O)	100.00	99.33	180.52	223.69	219.39	252.17	315.48	453.99
12	Computed Value /Expected Values (E)	73.52	118.39	163.26	208.13	253.01	297.88	342.75	387.63
13	Chi-Square $(O-E)^2/E$	9.5415	3.0670	1.8243	1.1618	4.4674	7.0145	2.1700	11.3622

Average Material Productivity Indices=230.57, a=230.57, b=22.44, χ^2=40.609, S.D.=108.71, C.V.= 47.15%.

Analysis and Interpretation

Output: The output of Wipro Ltd. is conveying a fluctuating trend. Output in 2010-11 is ₹ 26949.60 crore, in 2011-12 ₹ 30252.87 crore, in 2012-13 ₹ 29664.36 crore, in 2013-14 ₹ 32941.35 crore, in 2014-15 ₹ 35024.33 crore, in 2015-16 ₹ 39676.31 crore, in 2016-17 ₹ 40209.89 crore and in 2017-18 ₹ 37750.59 crore.

Raw Material and Components: The raw material and components element of Wipro Ltd. is the highest ₹ 1328.81 crore in 2011-12 while it is as low as ₹ 0.17

crore in 2015-16. There is no raw material and components element in the year 2016-17 and 2017-18.

Stores and Spares: Stores and spares are displaying the abnormal values. It is not available in the year 2012-13, 2016-17 and 2017-18. Its input output ratio is 0.0008 in 2010-11, 0.0009 in 2011-12, 0.0014 in 2013-14 and -0.0001 in 2014-15.

Purchases of Traded Goods: Purchases of traded goods demonstrates inconsistent trend. It is the minimum ₹ 1174.21 crore in 2017-18 while it is the maximum ₹ 2945.49 crore. Its input output ratio is the minimum 0.0311 in 2017-18 while it is the maximum 0.1001 in 2010-11.

Total Material: Total material input of Wipro Ltd. lies between ₹ 1174.21 crore and ₹ 4300.74 crore. Total material input output ratio is the highest 0.1422 in 2011-12 while it is the lowest 0.0311 in 2017-18. The lowest ratio indicates that material has been optimally utilized in the year 2017-18.

Material Productivity Ratio: Material productivity ratio is the highest 32.1498 in 2017-18 which means that for every ₹ of material input approximately ₹ 32 of output is obtained. It is the lowest 7.0343 in 2011-12 which means that for every ₹ of material input approximately ₹ 7 of output is obtained. So the highest material productivity ratio is better as it gives more output with small amount of input. Material efficiency can also be observed from the average of material indices which worked out as 230.57 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Wipro Ltd. is 108.71 with 47.15% of variability. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Wipro Ltd. is 40.609. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected. This means that the material productivity indices of the Wipro Ltd. for the study period are not same and cannot be represented by straight line trend or line of best fit.

4.5.4. Material Productivity of Metals Sector Companies

Metals sector companies' productivity has been shown from table 4.13 to 4.16.

Table 4.13

Material Productivity of Coal India Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	5473.42	8752.79	9829.37	13365.32	11696.91	14394.79	12656.19	7972.12
2	Raw Material and Components (₹ in Crore)	6.51	5.45	6.91	7.44	11.42	5.89	4.58	4.27
3	Raw Material and Components (Input Output Ratio)	0.0012	0.0006	0.0007	0.0006	0.0010	0.0004	0.0004	0.0005
4	Stores and Spares (₹ in Crore)	3.52	3.43	3.07	2.64	2.18	2.75	2.19	1.26
5	Stores and Spares (Input Output Ratio)	0.0006	0.0004	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002
6	Purchases of Traded Goods (₹ in Crore)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	Purchases of Traded Goods (Input Output Ratio)	-	-	-	-	-	-	-	-
8	Total Material Input (₹ in Crore)	10.03	8.89	9.97	10.09	13.60	8.64	6.77	5.54
9	Total Material (Input Output Ratio)	0.0018	0.0010	0.0010	0.0008	0.0012	0.0006	0.0005	0.0007
10	Material Productivity Ratio	545.7049	984.9824	985.5986	1,325.1675	860.2424	1,666.4806	1,870.8175	1,439.7720
11	Material Productivity Indices/ Observed Indices (O)	100.00	180.50	180.61	242.84	157.64	305.38	342.83	263.84
12	Computed Value /Expected Values (E)	128.05	154.81	181.57	208.32	235.08	261.84	288.60	315.35
13	Chi-Square $(O-E)^2/E$	6.1455	4.2623	0.0050	5.7172	25.5122	7.2407	10.1900	8.4159

Average Material Productivity Indices=221.70, a=221.70, b=13.38, χ^2= 67.489, S.D. = 75.99, C.V.= 34.28%.

Analysis and Interpretation

Output: The revalued output of Coal India Ltd. is manifesting a changeable trend. It is the highest ₹ 14394.79 crore in 2015-16 and it is the lowest ₹ 5473.42 crore in 2010-11.

Raw Material and Components: It lies between ₹ 4.27 crore and ₹ 11.42 crore. Its input output ratio is the highest 0.0012 in 2010-11 while it is the lowest 0.0004 in 2015-16 and 2016-17.

Stores and Spares: Stores and spares is the highest ₹ 3.52 crore in 2010-11 while it is the lowest ₹ 1.26 crore in 2017-18. Its input output ratio lies between 0.0002 and 0.0006.

Purchases of Traded Goods: There are no purchases of traded goods of Coal India Ltd.

Total Material: Total material input is ₹ 10.03 crore in 2010-11 and reached to ₹ 5.54 crore in 2017-18. Its input output ratio is the highest 0.0018 in 2010-11 while it is the lowest 0.0005 in 2016-17. The lowest material input output ratio means material has been best utilized in the year 2016-17.

Material Productivity Ratio: Material productivity ratio is the lowest 545.7049 in 2010-11 while it is the highest 1870.8175 in 2016-17. The higher ratio indicates efficiency in the utilisation of material. Average of material indices is 221.70 as compared to the base year index of 100 indicates material efficiency.

Testing Hypothesis and Interpretation: In Coal India Ltd. the standard deviation calculated is 75.99 and coefficient of variation is 34.28%. The computed value of chi-square is 67.489 while the table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is greater than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This represent that the material productivity indices of the company for the study period are not equal and cannot be represented by straight line trend or line of best fit.

Table 4.14

Material Productivity of Hindalco Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	23812.03	24607.23	23337.28	23092.10	28592.89	29776.75	30320.65	34617.98
2	Raw Material and Components (₹ in Crore)	15530.94	16379.95	14720.26	15344.29	16971.37	16078.31	17298.00	20300.78
3	Raw Material and Components (Input Output Ratio)	0.6522	0.6657	0.6308	0.6645	0.5936	0.5400	0.5705	0.5864
4	Stores and Spares (₹ in Crore)	382.57	466.33	504.32	403.39	483.26	573.28	665.17	708.86
5	Stores and Spares (Input Output Ratio)	0.0161	0.0190	0.0216	0.0175	0.0169	0.0193	0.0219	0.0205
6	Purchases of Traded Goods (₹ in Crore)	522.22	189.09	0.33	0.02	29.85	1.24	73.34	3.93
7	Purchases of Traded Goods (Input Output Ratio)	0.0219	0.0077	0.0000	0.0000	0.0010	0.0000	0.0024	0.0001
8	Total Material Input (₹ in Crore)	16,435.73	17,035.37	15,224.91	15,747.71	17,484.49	16,652.83	18,036.50	21,013.57
9	Total Material (Input Output Ratio)	0.6902	0.6923	0.6524	0.6820	0.6115	0.5593	0.5949	0.6070
10	Material Productivity Ratio	1.4488	1.4445	1.5328	1.4664	1.6353	1.7881	1.6811	1.6474
11	Material Productivity Indices/ Observed Indices (O)	100.00	99.70	105.80	101.21	112.88	123.42	116.03	113.71
12	Computed Value /Expected Values (E)	99.01	101.89	104.77	107.65	110.54	113.42	116.30	119.18
13	Chi-Square $(O-E)^2/E$	0.0100	0.0469	0.0101	0.3851	0.0495	0.8819	0.0006	0.2514

Average Material Productivity Indices= 109.09, a = 109.09, b = 1.44, χ^2 = 1.636, S.D. = 8.16, C.V. = 7.48%.

Analysis and Interpretation

Output: The output of Hindalco Ltd. is the highest ₹ 34617.98 crore in 2017-18 and the lowest ₹ 23092.10 crore in 2013-14.

Raw Material and Components: It is the highest ₹ 20300.78 crore in 2017-18 and the lowest ₹ 14720.26 crore in 2012-13. Its input output ratio is the highest 0.6657 in 2011-12 while it is the lowest 0.5400 in 2015-16.

Stores and Spares: Stores and spares section of material input is the highest ₹ 708.86 crore in 2017-18 while it is the lowest ₹ 382.57 crore in 2010-11. Input output ratio of stores and spares is the lowest 0.0161 in 2010-11 while it is the highest 0.0219 in 2016-17.

Purchases of Traded Goods: It is the lowest ₹ 0.02 crore in 2013-14 as compared to the highest ₹ 522.22 crore in 2010-11.

Total Material: Total material input consumption of Hindalco Ltd. lies between ₹ 15224.91 crore and ₹ 21013.57 crore. Total material input output ratio is the highest 0.6923 in 2011-12 while it is the lowest 0.5593 in 2015-16.

Material Productivity Ratio: Material productivity ratio is the lowest 1.4445 in 2011-12 while it is the highest 1.7881 in 2015-16. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the material input has not been utilized efficiently and mismanagement is responsible for low productivity. Material efficiency can also be observed from the average of material indices which worked out to 109.09. This indicates that on an average material input is utilized efficiently as compared to the base year.

Testing Hypothesis and Interpretation: Standard deviation of Hindalco Ltd. is 8.16 while its coefficient of variation is 7.48%. The computed value of chi-square is 1.636. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the material productivity indices of the Hindalco Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 4.15

Material Productivity of Tata Steel Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	29751.06	31762.04	33240.61	34552.29	33571.38	35358.24	43080.57	49400.88
2	Raw Material and Components (₹ in Crore)	6244.01	7357.19	8484.69	7897.01	9412.95	8118.91	10284.85	13485.23
3	Raw Material and Components (Input Output Ratio)	0.2099	0.2316	0.2553	0.2286	0.2804	0.2296	0.2387	0.2730
4	Stores and Spares (₹ in Crore)	1417.26	1554.61	1796.07	2130.76	1858.21	2029.82	2264.74	2641.85
5	Stores and Spares (Input Output Ratio)	0.0476	0.0489	0.0540	0.0617	0.0554	0.0574	0.0526	0.0535
6	Purchases of Traded Goods (₹ in Crore)	180.20	192.34	389.42	287.75	554.79	829.92	725.21	517.12
7	Purchases of Traded Goods (Input Output Ratio)	0.0061	0.0061	0.0117	0.0083	0.0165	0.0235	0.0168	0.0105
8	Total Material Input (₹ in Crore)	7,841.47	9,104.15	10,670.18	10,315.52	11,825.95	10,978.64	13,274.80	16,644.20
9	Total Material (Input Output Ratio)	0.2636	0.2866	0.3210	0.2985	0.3523	0.3105	0.3081	0.3369
10	Material Productivity Ratio	3.7941	3.4887	3.1153	3.3495	2.8388	3.2206	3.2453	2.9681
11	Material Productivity Indices/ Observed Indices (O)	100.00	91.95	82.11	88.28	74.82	84.89	85.54	78.23
12	Computed Value /Expected Values (E)	93.63	91.37	89.11	86.86	84.60	82.34	80.08	77.83
13	Chi-Square $(O-E)^2/E$	0.4337	0.0037	0.5505	0.0235	1.1299	0.0786	0.3711	0.0021

Average Material Productivity Indices = 85.73, a = 85.73, b = - 1.13, χ^2 = 2.593, S.D. = 7.40, C.V. = 8.63 %.

Analysis and Interpretation

Output: The output ranges between ₹ 29751.06 crore in 2010-11 and ₹ 49400.88 crore in 2017-18.

Raw Material and Components: It is ₹ 6244.01 crore in 2010-11 and reached to ₹ 13485.23 crore in 2017-18. Its input output ratio is the highest 0.2804 in 2014-15 while it is the lowest 0.2099 in 2010-11. The lowest raw material and components input output ratio indicates optimum raw material and components utilisation has been achieved in this year.

Stores and Spares: Stores and spares consumption is the highest ₹ 2641.85 crore in 2017-18 while it is the lowest ₹ 1417.26 crore in 2010-11. Its input output ratio is the lowest 0.0476 in 2010-11 as compared to the highest 0.0617 in 2013-14.

Purchases of Traded Goods: Traded goods purchased ranges from ₹ 180.20 crore to ₹ 829.92 crore. Its input output ratio is the lowest 0.0061 in 2010-11 and 2011-12 while it is the highest 0.0235 in 2015-16.

Total Material: Total material input of Tata Steel Ltd. is ₹ 7841.47 crore in 2010-11 and reached to ₹ 10670.18 crore in 2012-13 then it slowed down and reached to ₹ 10315.52 crore in 2013-14, ₹ 11825.95 crore in 2014-15, ₹ 10978.64 crore in 2015-16 and ultimately it increased and reached to ₹ 16644.20 crore in 2017-18. Total material input output ratio is the highest 0.3523 in 2014-15 while it is the lowest 0.2636 in 2010-11. The lowest material input output ratio means material has been best utilized in the year 2010-11.

Material Productivity Ratio: Material productivity ratio of Tata Steel Ltd. is the lowest 2.8388 in 2014-15 while it is the highest 3.7941 in 2010-11. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the material input has not been utilized efficiently as compared to other years. Improvement in material efficiency can also be observed from the average of material indices which is 85.73 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Tata Steel Ltd. is 7.40 with 8.63% of variability. The computed value of chi-square is 2.593 as compared to the table value 14.067 at 5% level of significance with (8-1) = 7 degree of freedom. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the material productivity indices of the Tata Steel Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 4.16

Material Productivity of Vedanta Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	7996.15	6378.58	2133.63	24314.13	28028.71	32447.13	37817.67	39453.82
2	Raw Material and Components (₹ in Crore)	397.35	525.24	192.92	14643.60	15192.85	14366.27	15462.52	20141.99
3	Raw Material and Components (Input Output Ratio)	0.0497	0.0823	0.0904	0.6023	0.5420	0.4428	0.4089	0.5105
4	Stores and Spares (₹ in Crore)	244.58	257.07	137.41	298.01	488.15	453.66	590.09	415.48
5	Stores and Spares (Input Output Ratio)	0.0306	0.0403	0.0644	0.0123	0.0174	0.0140	0.0156	0.0105
6	Purchases of Traded Goods (₹ in Crore)	536.39	336.92	90.87	668.51	804.76	874.87	477.34	340.37
7	Purchases of Traded Goods (Input Output Ratio)	0.0671	0.0528	0.0426	0.0275	0.0287	0.0270	0.0126	0.0086
8	Total Material Input (₹ in Crore)	1,178.32	1,119.23	421.19	15,610.12	16,485.76	15,694.80	16,529.96	20,897.85
9	Total Material (Input Output Ratio)	0.1474	0.1755	0.1974	0.6420	0.5882	0.4837	0.4371	0.5297
10	Material Productivity Ratio	6.7861	5.6991	5.0657	1.5576	1.7002	2.0674	2.2878	1.8879
11	Material Productivity Indices/ Observed Indices (O)	100.00	83.98	74.65	22.95	25.05	30.47	33.71	27.82
12	Computed Value /Expected Values (E)	86.79	76.23	65.67	55.11	44.55	33.99	23.43	12.87
13	Chi-Square $(O-E)^2/E$	2.0107	0.7884	1.2275	18.7638	8.5316	0.3654	4.5142	17.3705

Average Material Productivity Indices= 49.83, a= 49.83, b= - 5.28, χ^2= 53.572, S.D. = 29.06, C.V.= 58.31%.

Analysis and Interpretation

Output: The revalued output of Vedanta Ltd. is the highest ₹ 39453.82 crore in 2017-18 while it is the lowest ₹ 2133.63 crore in 2012-13.

Raw Material and Components: It is the highest ₹ 20141.99 crore in 2017-18 and the lowest ₹ 192.92 crore in 2012-13. Raw materials and components input output ratio is the highest 0.6023 in 2013-14 while it is the lowest 0.0497 in 2010-11.

Stores and Spares: Stores and spares consumption is the highest ₹ 590.09 crore in 2016-17 while it is the lowest ₹ 137.41 crore in 2012-13. Input output ratio of stores and spares is the lowest 0.0105 in 2017-18 as compared to the highest 0.0644 in 2012-13.

Purchases of Traded Goods: It is the lowest ₹ 90.87 crore in 2012-13 as compared to the highest ₹ 874.87 crore in 2015-16. Input output ratio is the lowest 0.0086 in 2017-18 indicates less traded goods have been purchased for the purpose of business. It is the highest 0.0671 in 2010-11.

Total Material: Total material input consumption of Vedanta Ltd. is ₹ 1178.32 crore in 2010-11 and reached to ₹ 20897.85 crore in 2017-18. Total material input output ratio is the highest 0.6420 in 2013-14 while it is the lowest 0.1474 in 2010-11. The lowest material input output ratio means total material is the best utilized in the year 2010-11.

Material Productivity Ratio: Material productivity ratio is the lowest 1.5576 in 2013-14 while it is the highest 6.7861 in 2010-11. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the material input has not been utilized efficiently. Material efficiency can also be analysed from the average of material indices. It is 49.83 which is less than the base year index.

Testing Hypothesis and Interpretation: The standard deviation of Vedanta Ltd. is 29.06 with coefficient of variation 58.31%. The computed value of chi-square is 53.572. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected. This highlighted the fact that the material productivity indices of the Vedanta Ltd. for the study period are not same and cannot be represented by straight line trend or line of best fit.

4.5.5. Material Productivity of Pharmaceutical Sector Companies

Material productivity of pharmaceutical sector companies has been displayed from table 4.17 to 4.20.

Table 4.17

Material Productivity of Cipla Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	6308.14	6551.80	6992.95	7754.00	8004.10	10480.54	9185.26	9242.54
2	Raw Material and Components (₹ in Crore)	2315.04	2112.18	2273.63	2566.60	2761.95	3041.11	2432.82	2639.34
3	Raw Material and Components (Input Output Ratio)	0.3670	0.3224	0.3251	0.3310	0.3451	0.2902	0.2649	0.2856
4	Stores and Spares (₹ in Crore)	99.73	84.06	74.24	68.58	67.88	93.98	77.48	95.58
5	Stores and Spares (Input Output Ratio)	0.0158	0.0128	0.0106	0.0088	0.0085	0.0090	0.0084	0.0103
6	Purchases of Traded Goods (₹ in Crore)	671.13	509.99	607.22	631.09	728.15	868.44	929.16	850.32
7	Purchases of Traded Goods (Input Output Ratio)	0.1064	0.0778	0.0868	0.0814	0.0910	0.0829	0.1012	0.0920
8	Total Material Input (₹ in Crore)	3,085.90	2,706.24	2,955.09	3,266.28	3,557.98	4,003.52	3,439.46	3,585.25
9	Total Material (Input Output Ratio)	0.4892	0.4131	0.4226	0.4212	0.4445	0.3820	0.3745	0.3879
10	Material Productivity Ratio	2.0442	2.4210	2.3664	2.3740	2.2496	2.6178	2.6706	2.5779
11	Material Productivity Indices/ Observed Indices (O)	100.00	118.43	115.76	116.13	110.05	128.06	130.64	126.11
12	Computed Value /Expected Values (E)	106.71	109.98	113.25	116.51	119.78	123.05	126.32	129.59
13	Chi-Square $(O-E)^2/E$	0.4215	0.6505	0.0560	0.0013	0.7911	0.2039	0.1477	0.0935

Average Material Productivity Indices = 118.15, a = 118.15, b= 1.63, χ^2 = 2.365, S.D. = 9.50, C.V. = 8.04%.

Analysis and Interpretation

Output: The revalued output of Cipla Ltd. has an increasing trend except in the year 2016-17 and 2017-18. It is the highest ₹ 10480.54 crore in 2015-16 and it is the lowest ₹ 6308.14 crore in 2010-11.

Raw Material and Components: The most important segment of the material input is raw material and components. It is ₹ 2315.04 crore in 2010-11, ₹ 2112.18

crore in 2011-12, ₹ 2273.63 crore in 2012-13, ₹ 2566.60 crore in 2013-14, ₹ 2761.95 crore in 2014-15, ₹ 3041.11 crore in 2015-16, ₹ 2432.82 crore in 2016-17 and ₹ 2639.34 crore in 2017-18. Raw material and components input output ratio is the highest 0.3670 in 2010-11 while it is the lowest 0.2649 in 2016-17. The lowest raw material and components input output ratio indicates optimum raw material and components utilisation has been achieved in this year.

Stores and Spares: Another part of the total material input is stores and spares. The input output ratio of stores and spares is the lowest 0.0084 in 2016-17 as compared to the highest 0.0158 in 2010-11. This indicates stores and spares is optimally utilized in 2016-17.

Purchases of Traded Goods: Purchases of traded goods input output ratio is the lowest 0.0778 in 2011-12 indicates optimum utilisation.

Total Material: Total material input is representing an erratic trend. Its input output ratio 0.4892 in 2010-11, 0.4131 in 2011-12, 0.4226 in 2012-13, 0.4212 in 2013-14, 0.4445 in 2014-15, 0.3820 in 2015-16, 0.3745 in 2016-17 and 0.3879 in 2017-18 respectively. The lowest material input output ratio in the year 2016-17 with 0.3745. This means material is the best utilized in the year 2016-17.

Material Productivity Ratio: There is inconstant trend in the material productivity ratios of Cipla Ltd. It is 2.0442 in 2010-11, 2.4210 in 2011-12, 2.3664 in 2012-13, 2.3740 in 2013-14, 2.2496 in 2014-15, 2.6178 in 2015-16, 2.6706 in 2016-17 and 2.5779 in 2017-18. Material productivity ratio is the lowest 2.0442 in 2010-11 while it is the highest 2.6706 in 2016-17. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the material input has not been utilized efficiently and mismanagement may be responsible for the low productivity. Improvement in material efficiency can also be observed from the average of material indices which worked out as 118.15 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation is 9.50 with 8.04% of variability .The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Cipla Ltd. is 2.365. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative

hypothesis is rejected. This reveals that the material productivity indices of the Cipla Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 4.18

Material Productivity of Dr. Reddy's Laboratories Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	5345.10	6165.93	7280.11	7922.46	8225.15	8724.64	8487.52	7599.85
2	Raw Material and Components (₹ in Crore)	1065.40	1596.03	1956.20	1788.51	1812.21	1664.37	1567.49	1606.79
3	Raw Material and Components (Input Output Ratio)	0.1993	0.2588	0.2687	0.2258	0.2203	0.1908	0.1847	0.2114
4	Stores and Spares (₹ in Crore)	353.10	70.41	87.19	77.19	302.65	359.16	373.97	405.89
5	Stores and Spares (Input Output Ratio)	0.0661	0.0114	0.0120	0.0097	0.0368	0.0412	0.0441	0.0534
6	Purchases of Traded Goods (₹ in Crore)	331.00	282.38	337.67	382.70	424.04	510.90	552.64	536.61
7	Purchases of Traded Goods (Input Output Ratio)	0.0619	0.0458	0.0464	0.0483	0.0516	0.0586	0.0651	0.0706
8	Total Material Input (₹ in Crore)	1,749.50	1,948.82	2,381.06	2,248.41	2,538.90	2,534.44	2,494.10	2,549.29
9	Total Material (Input Output Ratio)	0.3273	0.3161	0.3271	0.2838	0.3087	0.2905	0.2939	0.3354
10	Material Productivity Ratio	3.0552	3.1639	3.0575	3.5236	3.2397	3.4424	3.4030	2.9812
11	Material Productivity Indices/ Observed Indices (O)	100.00	103.56	100.07	115.33	106.04	112.67	111.38	97.58
12	Computed Value /Expected Values (E)	103.72	104.32	104.92	105.53	106.13	106.73	107.34	107.94
13	Chi-Square $(O-E)^2/E$	0.1333	0.0056	0.2242	0.9106	0.0001	0.3306	0.1526	0.9952

Average Material Productivity Indices = 105.83, a = 105.83, b= 0.30, χ^2 = 2.752, S.D. = 6.21, C.V. = 5.87%.

Analysis and Interpretation

Output: The revalued output of Dr. Reddy's Laboratories Ltd. for the year 2010-11 is ₹ 5345.10 crore, for year 2011-12 it becomes ₹ 6165.93 crore, for 2012-13 it is ₹ 7280.11 crore, for 2013-14 ₹ 7922.46 crore, for 2014-15 ₹ 8225.15 crore, for 2015-16 output is ₹ 8724.64 crore, for 2016-17 ₹ 8487.52 crore and for 2017-18 it is ₹ 7599.85 crore.

Raw Material and Components: The raw material and components factor in total material input in Dr. Reddy's Laboratories Ltd. is ₹ 1065.40 crore, ₹ 1596.03 crore, ₹ 1956.20 crore, ₹ 1788.51 crore, ₹ 1812.21 crore, ₹ 1664.37 crore, ₹ 1567.49 crore and ₹ 1606.79 crore respectively from 2010-11 to 2017-18. Raw material and components input output ratio presents the changing trend that is in some year it is decreasing and in some year it is increasing. It is the highest 0.2687 in 2012-13 while it is the lowest 0.1847 in 2016-17 indicates that raw material and components are optimally utilized in year 2016-17.

Stores and Spares: Another aspect to analyse in the total material input is stores and spares. It is ₹ 353.10 crore in 2010-11, ₹ 70.41 crore in 2011-12, ₹ 87.19 crore in 2012-13, ₹ 77.19 crore in 2013-14, ₹ 302.65 crore in 2014-15 and ₹ 359.16

crore in 2015-16, ₹ 373.97 crore in 2016-17 and ₹ 405.89 crore in 2017-18. Also stores and spares input output ratio is calculated which is the highest in 2010-11 i.e. 0.0661 and the lowest in 2013-14 i.e. 0.0097. This means that stores and spares has been the best utilized in 2013-14 as compared to other years.

Purchases of Traded Goods: Input output ratio of purchases of traded goods is 0.0619 in 2010-11, 0.0458 in 2011-12, 0.0464 in 2012-13, 0.0483 in 2013-14, 0.0516 in 2014-15, 0.0586 in 2015-16, 0.0651 in 2016-17 and 0.0706 in 2017-18.

Total Material: Total material input output ratio 0.3273 in 2010-11, 0.3161 in 2011-12, 0.3271 in 2012-13, 0.2838 in 2013-14, 0.3087 in 2014-15, 0.2905 in 2015-16, 0.2939 in 2016-17 and 0.3354 in 2017-18 respectively. It is the highest in 2017-18 which indicates that the maximum material remained unutilised in 2017-18 as compared to other years in the study.

Material Productivity Ratio: Material productivity ratio is inconsistent in nature. It is 3.0552 in 2010-11, 3.1639 in 2011-12, then it slightly decreased to 3.0575 in 2012-13, then again increased to 3.5236 in 2013-14, then it lowered down to 3.2397 in 2014-15, ultimately it increased to 3.4424 in 2015-16, it is 3.4030 in 2016-17 and lastly it is 2.9812 in 2017-18. Material productivity ratio is the lowest 2.9812 in 2017-18 while it is the highest 3.5236 in 2013-14. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the material input has not been utilized efficiently. Improvement in material efficiency can also be observed from the average of material indices which is 105.83 as compared to the base year.

Testing Hypothesis and Interpretation: The standard deviation of Dr. Reddy's Laboratories Ltd. is 6.21 with 5.87% of variability. For testing the hypothesis chi-square method has been used. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Dr. Reddy's Laboratories Ltd. is 2.752. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This reveals that the material productivity indices of the Dr. Reddy's Laboratories Ltd. for the eight year period are approximately the same and can be represented by straight line trend or line of best fit.

Table 4.19

Material Productivity of Lupin Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	4510.95	4824.82	5981.54	7571.30	7868.41	9452.23	10416.18	8232.87
2	Raw Material and Components (₹ in Crore)	1382.42	1461.61	1655.47	1739.71	1804.89	1964.22	1816.21	1805.36
3	Raw Material and Components (Input Output Ratio)	0.3065	0.3029	0.2768	0.2298	0.2294	0.2078	0.1744	0.2193
4	Stores and Spares (₹ in Crore)	154.57	170.75	190.03	214.01	266.03	341.23	386.73	314.21
5	Stores and Spares (Input Output Ratio)	0.0343	0.0354	0.0318	0.0283	0.0338	0.0361	0.0371	0.0382
6	Purchases of Traded Goods (₹ in Crore)	384.19	550.13	666.61	676.62	759.66	926.33	1086.53	902.99
7	Purchases of Traded Goods (Input Output Ratio)	0.0852	0.1140	0.1114	0.0894	0.0965	0.0980	0.1043	0.1097
8	Total Material Input (₹ in Crore)	1,921.18	2,182.49	2,512.11	2,630.34	2,830.58	3,231.78	3,289.47	3,022.57
9	Total Material (Input Output Ratio)	0.4259	0.4523	0.4200	0.3474	0.3597	0.3419	0.3158	0.3671
10	Material Productivity Ratio	2.3480	2.2107	2.3811	2.8784	2.7798	2.9248	3.1665	2.7238
11	Material Productivity Indices/ Observed Indices (O)	100.00	94.15	101.41	122.59	118.39	124.56	134.86	116.00
12	Computed Value /Expected Values (E)	98.13	102.66	107.20	111.73	116.26	120.80	125.33	129.86
13	Chi-Square $(O-E)^2/E$	0.0357	0.7054	0.3124	1.0559	0.0389	0.1175	0.7245	1.4792

Average Material Productivity Indices= 114.00, a=114.00, b = 2.27, χ^2 = 4.469, S.D. = 13.39, C.V. = 11.57%.

Analysis and Interpretation

Output: The output of Lupin Ltd. is displays an increasing trend. It is ₹ 4510.95 crore for the year 2010-11 and it reached to ₹ 8232.87 crore in 2017-18.

Raw Material and Components: The raw material and components are forming the major part of the material productivity of Lupin Ltd. It is ₹ 1382.42 crore in 2010-11 and it reached to ₹ 1805.36 crore in 2017-18. Raw material and components input output ratio is displaying the decreasing trend except in the year 2017-18. It is 0.3065 in 2010-11, 0.3029 in 2011-12, 0.2768 in 2012-13, 0.2298 in 2013-14, 0.2294 in 2014-15, 0.2078 in 2015-16, 0.1744 in 2016-17 and 0.2193 in 2017-18. This means that for one rupee of output, 0.3065 as input is required in 2010-11 and so on.

Stores and Spares: Another factor in total material input is stores and spares. It is ₹ 154.57 crore in 2010-11 and reached to ₹ 314.21 crore in 2017-18. Also stores and spares input output ratio is 0.0343, 0.0354, 0.0318, 0.0283, 0.0338, 0.0361, 0.0371 and 0.0382 respectively. It is the highest 0.0382 in 2017-18 while it is the lowest in 0.0283 in 2013-14. The lowest stores and spares input output ratio indicates that stores and spares have been best utilized in the year 2013-14.

Purchases of Traded Goods: Purchases of traded goods is ₹ 384.19 crore in 2010-11, ₹ 550.13 crore in 2011-12, ₹ 666.61 crore in 2012-13, ₹ 676.62 crore in 2013-14, ₹ 759.66 crore in 2014-15, ₹ 926.33 crore in 2015-16, ₹ 1086.53 crore in

2016-17 and ₹ 902.99 crore in 2017-18. Input output ratio is 0.0852 in 2010-11 and reached to 0.1097 in 2017-18.

Total Material: Total material of Lupin Ltd. is showing an upward trend except in the year 2017-18. Total material input output ratio 0.4259 in 2010-11, 0.4523 in 2011-12, 0.4200 in 2012-13, 0.3474 in 2013-14, 0.3597 in 2014-15, 0.3419 in 2015-16, 0.3158 in 2016-17 and 0.3671 in 2017-18 respectively. Total material input output ratio is the lowest in the year 2016-17 with 0.3158 indicating that material has been optimally utilized in this year.

Material Productivity Ratio: Material productivity ratio is showing a choppy trend. It is 2.3480 in 2010-11, decreased to 2.2107 in 2011-12, then it slightly increased to 2.3811 in 2012-13, then again increased to 2.8784 in 2013-14, then it lowered down to 2.7798 in 2014-15, then again it increased to 2.9248 in 2015-16, 3.1665 in 2016-17, then ultimately reached to 2.7238 in 2017-18. The highest material productivity ratio in 2016-17 with 3.1665 indicates that material is the best utilized in 2016-17. It represents that for every ₹ of input ₹ 3.1665 of output is obtained in 2016-17. Improvement in material efficiency can also be observed from the average of material indices which worked out as 114.00 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Lupin Ltd. is 13.39 with coefficient of variation 11.57%. Chi-square has been used for testing the hypothesis and its table value at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Lupin Ltd. is 4.469. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This reveals that the material productivity indices of the Lupin Ltd. for the eight years period are approximately the same and can be represented by straight line trend or line of best fit.

Table 4.20

Material Productivity of Sun Pharmaceutical Industries Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	3300.23	3925.99	2283.03	2426.49	6888.78	6677.42	6699.57	7378.69
2	Raw Material and Components (₹ in Crore)	718.26	873.67	606.27	730.01	1822.45	1690.61	1834.01	1731.85
3	Raw Material and Components (Input Output Ratio)	0.2176	0.2225	0.2656	0.3009	0.2646	0.2532	0.2738	0.2347
4	Stores and Spares (₹ in Crore)	33.91	108.87	146.99	150.90	278.46	301.64	353.34	375.89
5	Stores and Spares (Input Output Ratio)	0.0103	0.0277	0.0644	0.0622	0.0404	0.0452	0.0527	0.0509
6	Purchases of Traded Goods (₹ in Crore)	176.68	172.11	172.62	150.99	752.98	979.29	1017.64	931.63
7	Purchases of Traded Goods (Input Output Ratio)	0.0535	0.0438	0.0756	0.0622	0.1093	0.1467	0.1519	0.1263
8	Total Material Input (₹ in Crore)	928.85	1,154.65	925.89	1,031.91	2,853.90	2,971.54	3,204.99	3,039.36
9	Total Material (Input Output Ratio)	0.2815	0.2941	0.4056	0.4253	0.4143	0.4450	0.4784	0.4119
10	Material Productivity Ratio	3.5530	3.4002	2.4658	2.3515	2.4138	2.2471	2.0904	2.4277
11	Material Productivity Indices/ Observed Indices (O)	100.00	95.70	69.40	66.18	67.94	63.25	58.83	68.33
12	Computed Value /Expected Values (E)	91.32	86.28	81.25	76.22	71.19	66.15	61.12	56.09
13	Chi-Square $(O-E)^2/E$	0.8257	1.0270	1.7289	1.3217	0.1483	0.1279	0.0857	2.6707

Average Material Productivity Indices= 73.70, a= 73.70, b = -2.52, χ^2 = 7.936, S.D. = 14.33, C.V. = 19.44%.

Analysis and Interpretation

Output: The output of Sun Pharmaceutical Industries Ltd. presenting a changeful trend. Output in 2010-11 is ₹ 3300.23 crore, in 2011-12 ₹ 3925.99 crore, in 2012-13 ₹ 2283.03 crore, in 2013-14 ₹ 2426.49 crore, in 2014-15 ₹ 6888.78 crore, in 2015-16 ₹ 6677.42 crore, in 2016-17 ₹ 6699.57 crore, in 2017-18 ₹ 7378.69 crore.

Raw Material and Components: The raw material and components of Sun Pharmaceutical Industries Ltd. is ₹ 718.26 crore in 2010-11, ₹ 873.67 crore in 2011-12, ₹ 606.27 crore in 2012-13, ₹ 730.01 crore in 2013-14, ₹ 1822.45 crore in 2014-15, ₹ 1690.61 crore in 2015-16, ₹ 1834.01 crore in 2016-17 and ₹ 1731.85 crore in 2017-18. Raw material and components and output are highly consumed after the year 2013-14. The input output ratio is the lowest 0.2176 in 2010-11 while it is the highest 0.3009 in the year 2013-14. The lowest ratio indicates that the raw material and components is best utilized in the year 2010-11.

Stores and Spares: Another point to discuss in the total material input is stores and spares. It is showing an increasing trend with the lowest ₹ 33.91 crore in 2010-11 while it is the highest ₹ 375.89 crore in 2017-18. Also stores and spares input output ratio is 0.0103 in 2010-11, 0.0277 in 2011-12, 0.0644 in 2012-13, 0.0622 in 2013-14, 0.0404 in 2014-15, 0.0452 in 2015-16, 0.0527 in 2016-17 and 0.0509 in 2017-18. It is the lowest 0.0103 in 2010-11 which indicates that for every ₹ of output produced ₹ 0.0103 of input is required.

Purchases of Traded Goods: Purchases of traded goods is showing an erratic trend. Its input output ratio is 0.0535 in 2010-11, 0.0438 in 2011-12, 0.0756 in 2012-13, 0.0622 in 2013-14, 0.1093 in 2014-15, 0.1467 in 2015-16, 0.1519 in 2016-17 and 0.1263 in 2017-18.

Total Material: Total material input of Sun Pharmaceutical Industries Ltd. is showing a fluctuating trend. It is ₹ 928.85 crore in 2010-11, ₹ 1154.65 crore in 2011-12, ₹ 925.89 crore in 2012-13, ₹ 1031.91 crore in 2013-14, ₹ 2853.90 crore in 2014-15, ₹ 2971.54 crore in 2015-16, ₹ 3204.99 crore in 2016-17 and ₹ 3039.36 crore in 2017-18. Total material input output ratio is 0.2815 in 2010-11, 0.2941 in 2011-12, 0.4056 in 2012-13, 0.4253 in 2013-14, 0.4143 in 2014-15, 0.4450 in 2015-16, 0.4784 in 2016-17, 0.4119 in 2017-18 respectively. Total material input output ratio is the highest 0.4784 in 2016-17 while it is the lowest 0.2815 in 2010-11. The lowest ratio indicates that material has been best utilized in the year 2010-11. Material efficiency can also be observed from the average of material indices which worked out as 73.70 as compared to the base year index of 100. This indicates that material is not being able to utilize efficiently as compared to the base year.

Material Productivity Ratio: Material productivity ratio is 3.5530 in 2010-11, 3.4002 in 2011-12, 2.4658 in 2012-13, 2.3515 in 2013-14 , 2.4138 in 2014-15, 2.2471 in 2015-16, 2.0904 in 2016-17, 2.4277 in 2017-18. It is the highest 3.5530 in 2010-11 which means that for every ₹ of input ₹ 3.5530 of output is obtained. It is the lowest 2.0904 in 2016-17 which means that for every ₹ of input ₹ 2.0904 of output is obtained. So the highest material productivity ratio is better as it gives more output with small amount of input.

Testing Hypothesis and Interpretation: The standard deviation of Sun Pharmaceutical Industries Ltd. is 14.33 with 19.44% of variability. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Sun Pharmaceutical Industries Ltd. is 7.936. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This reveals that the material productivity indices of the Sun Pharmaceutical

Industries Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

4.5.6. Material Productivity of Refineries Sector Companies

Material productivity of refineries sector companies has been depicted from table 4.21 to 4.24.

Table 4.21

Material Productivity of Bharat Petroleum Corporation Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	151243.98	195601.15	206438.48	211751.09	197308.95	160737.40	163969.29	191476.02
2	Raw Material and Components (₹ in Crore)	62869.68	78690.25	83879.68	89240.03	76227.25	51225.12	55870.33	65235.11
3	Raw Material and Components (Input Output Ratio)	0.4157	0.4023	0.4063	0.4214	0.3863	0.3187	0.3407	0.3407
4	Stores and Spares (₹ in Crore)	53.25	53.64	57.24	53.31	96.40	68.43	9.48	0.00
5	Stores and Spares (Input Output Ratio)	0.0004	0.0003	0.0003	0.0003	0.0005	0.0004	0.0001	-
6	Purchases of Traded Goods (₹ in Crore)	78105.10	102962.10	108079.04	106812.66	94343.68	84312.68	94003.13	100244.72
7	Purchases of Traded Goods(Input Output Ratio)	0.5164	0.5264	0.5235	0.5044	0.4782	0.5245	0.5733	0.5235
8	Total Material Input (₹ in Crore)	141,028.03	181,705.99	192,015.96	196,106.00	170,667.32	135,606.24	149,882.95	165,479.84
9	Total Material (Input Output Ratio)	0.9325	0.9290	0.9301	0.9261	0.8650	0.8437	0.9141	0.8642
10	Material Productivity Ratio	1.0724	1.0765	1.0751	1.0798	1.1561	1.1853	1.0940	1.1571
11	Material Productivity Indices/ Observed Indices (O)	100.00	100.38	100.25	100.68	107.80	110.53	102.01	107.89
12	Computed Value /Expected Values (E)	99.47	100.68	101.88	103.09	104.30	105.50	106.71	107.92
13	Chi-Square $(O-E)^2/E$	0.0028	0.0009	0.0262	0.0561	0.1178	0.2392	0.2071	0.0000

Average Material Productivity Indices= 103.69, a= 103.69, b = 0.60, χ^2 = 0.650, S.D. = 4.02, C.V. = 3.88 %.

Analysis and Interpretation

Output: The revalued output of Bharat Petroleum Corporation Ltd. is showing a fluctuating trend. It is the highest ₹ 211751.09 crore in 2013-14 and it is the lowest ₹ 151243.98 crore in 2010-11.

Raw Material and Components: It is regarded as the most important chunk. It is ₹ 62869.68 crore in 2010-11, ₹ 78690.25 crore in 2011-12, ₹ 83879.68 crore in 2012-13, ₹ 89240.03 crore in 2013-14, ₹ 76227.25 crore in 2014-15, ₹ 51225.12 crore in 2015-16, ₹ 55870.33 crore in 2016-17 and ₹ 65235.11 crore on 2017-18. Raw material and components input output ratio is the highest 0.4214 in 2013-14 while it is the lowest 0.3187 in 2015-16. The lowest raw material and components input output ratio indicates optimum raw material and components utilisation has been achieved in this year.

Stores and Spares: Stores and spares is the highest ₹ 96.40 crore in 2014-15 while it is the lowest ₹ 9.48 crore in 2016-17 while there is no consumption of stores and spares in the year 2017-18. Its input output ratio is the lowest 0.0001 in

2016-17 as compared to the highest 0.0005 in 2014-15 while input output is not able to calculate in the year 2017-18.

Purchases of Traded Goods: It is ₹ 78105.10 crore in 2010-11 while it reached to ₹ 100244.72 crore in 2017-18. Input output ratio is the lowest 0.4782 in 2014-15 indicates optimum utilisation.

Total Material: Total material input is ₹ 141028.03 crore in 2010-11 and reached to ₹ 165479.84 crore in 2017-18. Its input output ratio is the highest 0.9325 in 2010-11 while it is the lowest 0.8437 in 2015-16. The lowest material input output ratio means material has been best utilized in the year 2015-16.

Material Productivity Ratio: There is a fluctuating trend in the material productivity ratio of Bharat Petroleum Corporation Ltd. Material productivity ratio is 1.0724 in 2010-11, 1.0765 in 2011-12, 1.0751 in 2012-13, 1.0798 in 2013-14, 1.1561 in 2014-15, 1.1853 in 2015-16, 1.0940 in 2016-17 and 1.1571 in 2017-18. Material productivity ratio is the lowest 1.0724 in 2010-11 while it is the highest 1.1853 in 2015-16. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the material input has not been utilized efficiently. Improvement in material efficiency can also be observed from the average of material indices which worked out as 103.69 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: In Bharat Petroleum Corporation Ltd. the standard deviation calculated is 4.02 and coefficient of variation is 3.88% indicates less variability. The computed value of chi-square is 0.650 while the table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This highlighted the fact that the material productivity indices of the company for the study period are approximately equal and can be represented by straight line trend or line of best fit.

Table 4.22

Material Productivity of Hindustan Petroleum Corporation Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	131403.70	163897.08	179216.63	182515.82	170937.91	151402.12	151501.59	177367.29
2	Raw Material and Components (₹ in Crore)	40505.43	52440.66	54431.16	50735.36	45450.21	34159.34	37148.29	40897.85
3	Raw Material and Components (Input Output Ratio)	0.3083	0.3200	0.3037	0.2780	0.2659	0.2256	0.2452	0.2306
4	Stores and Spares (₹ in Crore)	116.66	111.45	134.34	136.93	196.83	193.05	243.79	195.23
5	Stores and Spares (Input Output Ratio)	0.0009	0.0007	0.0007	0.0008	0.0012	0.0013	0.0016	0.0011
6	Purchases of Traded Goods (₹ in Crore)	85396.86	100402.33	110092.82	118432.57	104198.36	97048.84	101008.22	113822.14
7	Purchases of Traded Goods (Input Output Ratio)	0.6499	0.6126	0.6143	0.6489	0.6096	0.6410	0.6667	0.6417
8	Total Material Input (₹ in Crore)	126,018.95	152,954.44	164,658.33	169,304.86	149,845.39	131,401.22	138,400.31	154,915.22
9	Total Material (Input Output Ratio)	0.9590	0.9332	0.9188	0.9276	0.8766	0.8679	0.9135	0.8734
10	Material Productivity Ratio	1.0427	1.0715	1.0884	1.0780	1.1408	1.1522	1.0947	1.1449
11	Material Productivity Indices/ Observed Indices (O)	100.00	102.76	104.38	103.39	109.40	110.50	104.98	109.80
12	Computed Value /Expected Values (E)	101.32	102.55	103.79	105.03	106.27	107.51	108.75	109.99
13	Chi-Square $(O-E)^2/E$	0.0171	0.0004	0.0033	0.0258	0.0922	0.0831	0.1306	0.0003

Average Material Productivity Indices= 105.65, a = 105.65, b = 0.62, χ^2 = 0.353, S.D. = 3.58, C.V. = 3.38%.

Analysis and Interpretation

Output: The revalued output of Hindustan Petroleum Corporation Ltd. is ₹ 131403.70 crore in 2010-11 and reached to ₹ 177367.29 crore in 2017-18.

Raw Material and Components: It is the highest ₹ 54431.16 crore in 2012-13 and the lowest ₹ 34159.34 crore in 2015-16. Its input output ratio is the highest 0.3200 in 2011-12 while it is the lowest 0.2256 in 2015-16.

Stores and Spares: Stores and spares is the highest ₹ 243.79 crore in 2016-17 while it is the lowest ₹ 111.45 crore in 2011-12. Input output ratio of stores and spares is the lowest 0.0007 in 2011-12 and 2012-13 while it is the highest 0.0016 in 2016-17.

Purchases of Traded Goods: It is the lowest in ₹ 85396.86 crore in 2010-11 as compared to ₹ 118432.57 crore in 2013-14. Input output ratio is 0.6499 in 2010-11, 0.6126 in 2011-12, 0.6143 in 2012-13, 0.6489 in 2013-14, 0.6096 in 2014-15, 0.6410 in 2015-16, 0.6667 in 2016-17 and 0.6417 in 2017-18. It is the lowest 0.6096 in 2014-15 indicates optimum traded goods have been purchased for the purpose of business.

Total Material: Total material input consumption is revealing an inconstant trend. It is ₹ 126018.95 crore in 2010-11, then it is increased to ₹ 152954.44 crore in 2011-12, then it increased to ₹ 164658.33 crore in 2012-13, then it again increased to ₹ 169304.86 crore in 2013-14, then it decreased to ₹ 149845.39 crore

in 2014-15, again decreased to ₹ 131401.22 crore in 2015-16, then finally increased to ₹ 138400.31 crore in 2016-17 and ₹ 154915.22 crore in 2017-18. Total material input output ratio is the highest 0.9590 in 2010-11 while it is the lowest 0.8679 in 2015-16.

Material Productivity Ratio: Material productivity ratio is 1.0427 in 2010-11, 1.0715 in 2011-12, 1.0884 in 2012-13, 1.0780 in 2013-14, 1.1408 in 2014-15, 1.1522 in 2015-16, 1.0947 in 2016-17 and 1.1449 in 2017-18. Material productivity ratio is the lowest 1.0427 in 2010-11 while it is the highest 1.1522 in 2015-16. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the material input has not been utilized efficiently and mismanagement is responsible for low productivity. Material efficiency can also be observed from the average of material indices which worked out as 105.65 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: Standard deviation of Hindustan Petroleum Corporation Ltd. is 3.58 while its coefficient of variation is 3.38%. The computed value of chi-square is 0.353. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the material productivity indices of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 4.23

Material Productivity of Indian Oil Corporation Ltd.from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	326553.94	399196.39	382590.88	387987.09	362608.32	298354.22	287130.68	343394.88
2	Raw Material and Components (₹ in Crore)	143241.25	186045.37	189137.57	185614.76	165854.80	119447.64	129523.77	151158.94
3	Raw Material and Components (Input Output Ratio)	0.4386	0.4660	0.4944	0.4784	0.4574	0.4004	0.4511	0.4402
4	Stores and Spares (₹ in Crore)	833.64	823.73	904.21	978.67	1216.53	1130.96	1133.11	1194.62
5	Stores and Spares (Input Output Ratio)	0.0026	0.0021	0.0024	0.0025	0.0034	0.0038	0.0039	0.0035
6	Purchases of Traded Goods (₹ in Crore)	155710.85	175176.81	161648.51	160129.51	143092.32	120217.31	116804.68	121541.92
7	Purchases of Traded Goods(Input Output Ratio)	0.4768	0.4388	0.4225	0.4127	0.3946	0.4029	0.4068	0.3539
8	Total Material Input (₹ in Crore)	299,785.74	362,045.91	351,690.29	346,722.95	310,163.65	240,795.91	247,461.57	273,895.48
9	Total Material (Input Output Ratio)	0.9180	0.9069	0.9192	0.8936	0.8554	0.8071	0.8618	0.7976
10	Material Productivity Ratio	1.0893	1.1026	1.0879	1.1190	1.1691	1.2390	1.1603	1.2537
11	Material Productivity Indices/ Observed Indices (O)	100.00	101.22	99.87	102.73	107.33	113.75	106.52	115.10
12	Computed Value /Expected Values (E)	98.38	100.50	102.63	104.75	106.88	109.00	111.12	113.25
13	Chi-Square $(O-E)^2/E$	0.0267	0.0051	0.0742	0.0391	0.0019	0.2068	0.1907	0.0302

Average Material Productivity Indices= 105.81, a = 105.81, b = 1.06, χ^2 = 0.575, S.D. = 5.61, C.V. = 5.30%.

Analysis and Interpretation

Output: The output of Indian Oil Corporation Ltd. conveys the fluctuating trend. It is ₹ 326553.94 crore in 2010-11, ₹ 399196.39 crore in 2011-12, ₹ 382590.88 crore in 2012-13, ₹ 387987.09 crore in 2013-14, ₹ 362608.32 in 2014-15, ₹ 298354.22 crore in 2015-16, ₹ 287130.68 crore in 2016-17 and ₹ 343394.88 crore in 2017-18.

Raw Material and Components: It is ₹ 143241.25 crore in 2010-11, ₹ 186045.37 crore in 2011-12, ₹ 189137.57 crore in 2012-13, ₹ 185614.76 crore in 2013-14, ₹ 165854.80 crore in 2014-15, ₹ 119447.64 crore in 2015-16, ₹ 129523.77 crore in 2016-17 and ₹ 151158.94 crore on 2017-18. Its input output ratio is the highest 0.4944 in 2012-13 while it is the lowest 0.4004 in 2015-16. The lowest raw material and components input output ratio indicates optimum raw material and components utilisation has been achieved in this year.

Stores and Spares: Stores and spares consumption is the highest ₹ 1216.53 crore in 2014-15 while it is the lowest ₹ 823.73 crore in 2011-12. Its input output ratio is the lowest 0.0021 in 2011-12 as compared to the highest 0.0039 in 2016-17.

Purchases of Traded Goods: Traded goods purchased recorded the highest ₹ 175176.81 crore in 2011-12 while it is the lowest ₹ 116804.68 crore in 2016-17. Its input output ratio is the lowest 0.3539 in 2017-18 while it is the highest 0.4768 in 2010-11.

Total Material: Total material input of Indian Oil Corporation Ltd. is ₹ 299785.74 crore in 2010-11, ₹ 362045.91 crore in 2011-12, ₹ 351690.29 crore in 2012-13, ₹ 346722.95 crore in 2013-14, ₹ 310163.65 crore in 2014-15, ₹ 240795.91 crore in 2015-16, ₹ 247461.57 crore in 2016-17 and ₹ 273895.48 crore in 2017-18. Total material input output ratio is the highest 0.9192 in 2012-13 while it is the lowest 0.7976 in 2017-18. The lowest material input output ratio means material has been best utilized in the year 2017-18.

Material Productivity Ratio: Material productivity ratio of Indian Oil Corporation Ltd. is 1.0893 in 2010-11, 1.1026 in 2011-12, 1.0879 in 2012-13, 1.1190 in 2013-14, 1.1691 in 2014-15, 1.2390 in 2015-16, 1.1603 in 2016-17 and 1.2537 in 2017-18. It is the lowest 1.0879 in 2012-13 while it is the highest 1.2537 in 2017-18. The highest ratio indicates efficiency and effectiveness while

the lowest ratio indicates that the material input has not been utilized efficiently. Improvement in material efficiency can also be observed from the average of material indices which is 105.81 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Indian Oil Corporation Ltd. is 5.61 with 5.30% of variability. The computed value of chi-square is 0.575 as compared to the table value 14.067 at 5% level of significance with (8-1) = 7 degree of freedom. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the material productivity indices of the Indian Oil Corporation Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 4.24

Material Productivity of Reliance Industries Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	247978.66	307735.63	313516.10	325963.44	273830.44	204990.51	202371.59	235728.97
2	Raw Material and Components (₹ in Crore)	193233.88	252279.25	262963.09	268719.41	206334.39	127867.65	135177.75	158225.17
3	Raw Material and Components (Input Output Ratio)	0.7792	0.8198	0.8388	0.8244	0.7535	0.6238	0.6680	0.6712
4	Stores and Spares (₹ in Crore)	3378.02	3196.48	3263.34	3627.94	3789.81	3988.31	4143.81	4295.42
5	Stores and Spares (Input Output Ratio)	0.0136	0.0104	0.0104	0.0111	0.0138	0.0195	0.0205	0.0182
6	Purchases of Traded Goods (₹ in Crore)	1464.31	1322.84	431.22	427.58	5750.00	3549.72	4247.50	5807.13
7	Purchases of Traded Goods (Input Output Ratio)	0.0059	0.0043	0.0014	0.0013	0.0210	0.0173	0.0210	0.0246
8	Total Material Input (₹ in Crore)	198,076.21	256,798.57	266,657.65	272,774.93	215,874.20	135,405.68	143,569.06	168,327.73
9	Total Material (Input Output Ratio)	0.7988	0.8345	0.8505	0.8368	0.7883	0.6605	0.7094	0.7141
10	Material Productivity Ratio	1.2519	1.1984	1.1757	1.1950	1.2685	1.5139	1.4096	1.4004
11	Material Productivity Indices/ Observed Indices (O)	100.00	95.72	93.91	95.45	101.32	120.92	112.59	111.86
12	Computed Value /Expected Values (E)	93.38	96.40	99.43	102.46	105.49	108.51	111.54	114.57
13	Chi-Square $(O-E)^2/E$	0.4697	0.0049	0.3064	0.4793	0.1645	1.4195	0.0099	0.0640

Average Material Productivity Indices = 103.97, a = 103.97, b = 1.51, χ^2 = 2.918, S.D. = 9.28, C.V. =8.92%.

Analysis and Interpretation

Output: The revalued output of Reliance Industries Ltd. is the highest ₹ 325963.44 crore in 2013-14 while it is the lowest ₹ 202371.59 crore in 2016-17.

Raw Material and Components: It is the highest ₹ 268719.41 crore in 2013-14 and the lowest ₹ 127867.65 crore in 2015-16. Raw materials and components input output ratio is 0.7792 in 2010-11, 0.8198 in 2011-12, 0.8388 in 2012-13, 0.8244 in 2013-14, 0.7535 in 2014-15, 0.6238 in 2015-16, 0.6680 in 2016-17 and 0.6712 in 2017-18. It is the highest 0.8388 in 2012-13 while it is the lowest 0.6238 in 2015-16.

Stores and Spares: Stores and spares consumption is the highest ₹ 4295.42 crore in 2017-18 while it is the lowest ₹ 3196.48 crore in 2011-12. Input output ratio of stores and spares is the lowest 0.0104 in 2011-12 and 2012-13 as compared to the highest 0.0205 in 2016-17.

Purchases of Traded Goods: It is the lowest ₹ 427.58 crore in 2013-14 as compared to ₹ 5807.13 crore in 2017-18. Input output ratio is the lowest 0.0013 in 2013-14 indicates less traded goods have been purchased for the purpose of business. It is the highest 0.0246 in 2017-18.

Total Material: Total material input consumption of Reliance Industries Ltd. is ₹ 198076.21 crore in 2010-11 and reached to ₹ 168327.73 crore in 2017-18. Total material input output ratio is the highest 0.8505 in 2012-13 while it is the lowest 0.6605 in 2015-16. The lowest material input output ratio means total material is best utilized in the year 2015-16.

Material Productivity Ratio: Material productivity ratio is 1.2519 in 2010-11, 1.1984 in 2011-12, 1.1757 in 2012-13, 1.1950 in 2013-14, 1.2685 in 2014-15, 1.5139 in 2015-16, 1.4096 in 2016-17 and 1.4004 in 2017-18. Material productivity ratio is the lowest 1.1757 in 2012-13 while it is the highest 1.5139 in 2015-16. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the material input has not been utilized efficiently. Material efficiency can also be analysed from the average of material indices. It is 103.97 which is higher than the base year index of 100. This indicates that on an average material is utilized efficiently in all the years.

Testing Hypothesis and Interpretation: The standard deviation of Reliance Industries Ltd. is 9.28 with coefficient of variation 8.92%. The computed value of chi-square is 2.918. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the material productivity indices of the Reliance Industries Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

4.6. Material Productivity Ratios and Kruskal Wallis One Way Analysis of Variance Test

To study the inter-company relationship, second hypothesis has been framed and tested with the help of kruskal wallis one way analysis of variance test. For this, the material productivity of all the samples of a particular sector is combined and arranged in order of increasing size and given a rank number. Where the tie occurs, the mean of the available rank numbers is used. The rank sum of each of the sample has been calculated. The detailed calculations have been made in the following tables.

Table 4.25

Comparative Material Productivity Ratios from 2010-11 to 2017-18 of Automobile Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	Bajaj Auto Ltd.		Mahindra & Mahindra Ltd.		Maruti Suzuki India Ltd.		Tata Motors Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	1.3874	13	1.4268	20	1.3012	2	1.3455	7
2011-12	1.3747	10	1.3076	3	1.2807	1	1.3207	5
2012-13	1.4102	16	1.3337	6	1.3576	8	1.3834	11
2013-14	1.4582	23	1.3701	9	1.4143	18	1.4782	26
2014-15	1.4420	22	1.4245	19	1.4097	15	1.3150	4
2015-16	1.5332	32	1.3871	12	1.4909	29	1.4821	27
2016-17	1.5269	31	1.4124	17	1.4778	25	1.3967	14
2017-18	1.4911	30	1.4630	24	1.4836	28	1.4413	21
Total		177		110		126		115

H = 4.026

Testing Hypothesis and Interpretation: The calculated value of H is 4.026 and the table value is 7.815 at 5 % level of significance with (4-1) = 3 degrees of freedom. As the calculated value is less than the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This means that the material productivity ratios of the automobile sector companies included in Nifty 50 are approximately same that is there is no significant difference in material productivity.

Table 4.26

Comparative Material Productivity Ratios from 2010-11 to 2017-18 of Energy Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	GAIL (India) Ltd.		NTPC Ltd.		Oil and Natural Gas Corporation Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3
2010-11	1.3689	8	1.6214	11	25.7044	23
2011-12	1.2926	4	1.5554	10	32.9977	24
2012-13	1.3155	5	1.6748	15	21.0564	22
2013-14	1.2446	1	1.6284	12	17.6893	20
2014-15	1.2675	3	1.5412	9	17.7666	21
2015-16	1.2635	2	1.6351	13	15.9717	18
2016-17	1.3454	7	1.6658	14	14.0248	17
2017-18	1.3372	6	1.7144	16	16.5290	19
Total		36		100		164

H = 20.480

Testing Hypothesis and Interpretation: While calculating the H value, Power Grid Corporation of India Ltd. has been excluded due to its irregular material productivity and unavailability of information related to raw material and components. Thus only three companies have been considered for comparison. The calculated value of H is 20.480 and the table value is 5.991 at 5% level of significance with (3-1) = 2 degrees of freedom. As the calculated value is more than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that the material productivity ratios of the energy sector companies included in Nifty 50 are not same that is there is a significant difference in material productivity.

Table 4.27

Comparative Material Productivity Ratios from 2010-11 to 2017-18 of Information Technology Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	Infosys Ltd.		Tata Consultancy Services Ltd.		Wipro Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3
2010-11	55.0456	17	1677.2400	20	7.0816	2
2011-12	51.7211	15	3517.6952	24	7.0343	1
2012-13	51.6706	14	2023.0244	22	12.7836	3
2013-14	49.8587	11	1703.6333	21	15.8404	5
2014-15	49.7417	10	1206.6317	19	15.5361	4
2015-16	52.9174	16	2249.6719	23	17.8576	6
2016-17	49.2504	9	55.2928	18	22.3411	7
2017-18	51.0526	12	51.4514	13	32.1498	8
Total		104		160		36

H = 19.280

Testing Hypothesis and Interpretation: While calculating the value of H, Tech Mahindra Ltd. has been excluded due to absence of raw material and components factor. Tata Consultancy Ltd. also has high fluctuations but it is considered in calculating the value of H. Thus only three companies have been considered for comparison. The calculated value of H is 19.280 and the table value is 5.991 at 5% level of significance with (3-1) = 2 degrees of freedom. As the calculated value is more than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that there is significant difference in the material productivity ratios of the information technology sector companies included in Nifty 50.

Table 4.28

Comparative Material Productivity Ratios from 2010-11 to 2017-18 of Metals Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

Year	Coal India Ltd.		Hindalco Ltd.		Tata Steel Ltd.		Vedanta Ltd.	
	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	545.7049	25	1.4488	2	3.7941	21	6.7861	24
2011-12	984.9824	27	1.4445	1	3.4887	20	5.6991	23
2012-13	985.5986	28	1.5328	4	3.1153	16	5.0657	22
2013-14	1325.1675	29	1.4664	3	3.3495	19	1.5576	5
2014-15	860.2424	26	1.6353	6	2.8388	14	1.7002	9
2015-16	1666.4806	31	1.7881	10	3.2206	17	2.0674	12
2016-17	1870.8175	32	1.6811	8	3.2453	18	2.2878	13
2017-18	1439.7720	30	1.6474	7	2.9681	15	1.8879	11
Total		228		41		140		119

H = 25.185

Testing Hypothesis and Interpretation: The calculated value of H is 25.185 and the table value is 7.815 at 5% level of significance with (4-1) = 3 degrees of freedom. As the calculated value is more than the table value hence null hypothesis is rejected. This means that the material productivity ratios of the metals sector companies included in Nifty 50 are not same. This reveals that there is significant difference in material productivity.

Table 4.29

Comparative Material Productivity Ratios from 2010-11 to 2017-18 of Pharmaceutical Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

Year	Cipla Ltd.		Dr. Reddy Laboratories Ltd.		Lupin Ltd.		Sun Pharmaceutical Industries Ltd.	
	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	2.0442	1	3.0552	23	2.3480	6	3.5530	32
2011-12	2.4210	12	3.1639	25	2.2107	3	3.4002	28
2012-13	2.3664	8	3.0575	24	2.3811	10	2.4658	14
2013-14	2.3740	9	3.5236	31	2.8784	20	2.3515	7
2014-15	2.2496	5	3.2397	27	2.7798	19	2.4138	11
2015-16	2.6178	16	3.4424	30	2.9248	21	2.2471	4
2016-17	2.6706	17	3.4030	29	3.1665	26	2.0904	2
2017-18	2.5779	15	2.9812	22	2.7238	18	2.4277	13
Total		83		211		123		111

H = 13.017

Testing Hypothesis and Interpretation: The calculated value of H is 13.017 and the table value is 7.815 at 5% level of significance with (4-1) = 3 degrees of freedom. As the calculated value is more than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that the material productivity ratios of the pharmaceutical sector companies included in Nifty 50 are not same reveals significant difference in material productivity.

Table 4.30

Comparative Material Productivity Ratios from 2010-11 to 2017-18 of Refineries Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	Bharat Petroleum Corporation Ltd.		Hindustan Petroleum Corporation Ltd.		Indian Oil Corporation Ltd.		Reliance Industries Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	1.0724	3	1.0427	1	1.0893	10	1.2519	27
2011-12	1.0765	5	1.0715	2	1.1026	13	1.1984	25
2012-13	1.0751	4	1.0884	9	1.0879	8	1.1757	22
2013-14	1.0798	7	1.0780	6	1.1190	14	1.1950	24
2014-15	1.1561	18	1.1408	15	1.1691	21	1.2685	29
2015-16	1.1853	23	1.1522	17	1.2390	26	1.5139	32
2016-17	1.0940	11	1.0947	12	1.1603	20	1.4096	31
2017-18	1.1571	19	1.1449	16	1.2537	28	1.4004	30
Total		90		78		140		220

H = 17.739

Testing Hypothesis and Interpretation: The calculated value of H is 17.739 and the table value is 7.815 at 5% level of significance with (4-1) = 3 degrees of freedom. As the calculated value is more than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that there is a significant difference in material productivity ratios of the refineries sector companies included in Nifty 50.

4.7. Possible Savings

Possible savings has been calculated to analyse what would have been saved if optimum utilisation of resources is made. Possible saving in material input has been calculated as under.

4.7.1. Possible Savings in Material Input of Automobile Sector Companies

Possible savings in total material input along with its three parts viz., raw material and components, stores and spares and purchases of traded goods have been portrayed as follows:

Table 4.31

Possible Savings in Material Input of Automobile Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bajaj Auto Ltd.	Mahindra & Mahindra Ltd.	Maruti Suzuki India Ltd.	Tata Motors Ltd.
2010-11	Standard	11017	16194	24864	31817
	Actual	12175	16605	28490	35047
	Saving	**1158**	**411**	**3626**	**3230**
2011-12	Standard	12000	19904	22339	33605
	Actual	13385	22270	26008	37713
	Saving	**1385**	**2366**	**3669**	**4108**
2012-13	Standard	11662	24021	25594	27072
	Actual	12680	26350	28108	29004
	Saving	**1018**	**2329**	**2514**	**1932**
2013-14	Standard	11089	22840	24377	21192
	Actual	11660	24390	25700	21249
	Saving	**571**	**1550**	**1323**	**57**
2014-15	Standard	11637	21825	27216	20286
	Actual	12374	22416	28785	22864
	Saving	**737**	**591**	**1569**	**2578**
2015-16	Standard	12918	23755	32682	25146
	Actual	12918	25056	32682	25146
	Saving	**0**	**1301**	**0**	**0**
2016-17	Standard	12316	25570	38614	25013
	Actual	12367	26488	38957	26543
	Saving	**51**	**918**	**343**	**1530**
2017-18	Standard	13821	27261	43862	33009
	Actual	14212	27261	44081	33943
	Saving	**391**	**0**	**219**	**934**
Total Savings		5311	9465	13262	14369

Note: Amount has been rounded off to nearest ₹

Table 4.31 suggests that the total possible savings in material input for a period of eight years would have been ₹ 5311 crore of Bajaj Auto Ltd., ₹ 9465 crore of Mahindra & Mahindra Ltd., ₹ 13262 crore of Maruti Suzuki India Ltd. and lastly ₹ 14369 crore of Tata Motors Ltd. For calculating possible savings year of the lowest material input output ratio has been taken as the base year. The year 2015-16 has been regarded as the base year for Bajaj Auto Ltd., Maruti Suzuki India Ltd. and Tata Motors Ltd. For Mahindra and Mahindra Ltd. base year is 2017-18.

1. **Possible Savings in Raw Material and Components of Automobile Sector Companies**

The most important part of material input is raw material and components. Table 4.32 elaborates the possible savings in raw material and components of material input of automobile sector companies under study.

Table 4.32

Possible Savings in Raw Material and Components of Automobile Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bajaj Auto Ltd.	Mahindra & Mahindra Ltd.	Maruti Suzuki India Ltd.	Tata Motors Ltd.
2010-11	Standard	9961	11012	20356	25106
	Actual	11522	14709	27142	27058
	Saving	**1561**	**3697**	**6786**	**1952**
2011-12	Standard	10850	13535	18289	26518
	Actual	12594	17263	24517	31115
	Saving	**1744**	**3728**	**6228**	**4598**
2012-13	Standard	10545	16335	20954	21362
	Actual	11836	17824	26070	23403
	Saving	**1292**	**1489**	**5116**	**2041**
2013-14	Standard	10027	15532	19958	16722
	Actual	10775	17650	23582	16722
	Saving	**749**	**2118**	**3624**	**0**
2014-15	Standard	10522	14842	22282	16008
	Actual	11337	16340	26491	17857
	Saving	**815**	**1498**	**4209**	**1849**
2015-16	Standard	11680	16154	26755	19841
	Actual	11740	16215	29887	20350
	Saving	**60**	**61**	**3131**	**509**
2016-17	Standard	11135	17390	31613	19737
	Actual	11135	17390	35084	22757
	Saving	**0**	**0**	**3471**	**3020**
2017-18	Standard	12496	18538	35908	26047
	Actual	12998	18589	35908	29627
	Saving	**502**	**51**	**0**	**3580**
Total Savings		6722	12642	32566	17549

Note: Amount has been rounded off to nearest ₹

Table 4.32 highlights that the total possible savings in raw material and components for a period of eight years might have been ₹ 6722 crore of Bajaj Auto Ltd., ₹ 12642 crore of Mahindra & Mahindra Ltd., ₹ 32566 crore of Maruti Suzuki India Ltd. and lastly ₹ 17549 crore of Tata Motors Ltd. For calculating possible savings year of the lowest raw material and components input output ratio has been taken as the base year. The year 2016-17 has been regarded as the base year for Bajaj Auto Ltd. and Mahindra and Mahindra Ltd. For Maruti Suzuki India Ltd. base year is 2017-18 while for Tata Motors Ltd. base year is 2013-14.

2. Possible Savings in Stores and Spares of Automobile Sector Companies

Another important aspect to discuss and analyse is stores and spares. Below details have been presented.

Table 4.33

Possible Savings in Stores and Spares of Automobile Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bajaj Auto Ltd.	Mahindra & Mahindra Ltd.	Maruti Suzuki India Ltd.	Tata Motors Ltd.
2010-11	Standard	74	83	70	490
	Actual	85	139	70	625
	Saving	**11**	**56**	**0**	**135**
2011-12	Standard	81	102	63	518
	Actual	101	149	84	691
	Saving	**20**	**47**	**21**	**173**
2012-13	Standard	79	123	73	417
	Actual	106	148	160	563
	Saving	**27**	**25**	**87**	**146**
2013-14	Standard	75	117	69	327
	Actual	102	149	134	406
	Saving	**27**	**32**	**65**	**79**
2014-15	Standard	79	112	77	313
	Actual	106	145	145	361
	Saving	**27**	**33**	**68**	**48**
2015-16	Standard	87	122	93	388
	Actual	110	128	179	394
	Saving	**23**	**6**	**86**	**6**
2016-17	Standard	83	133	109	386
	Actual	94	133	184	538
	Saving	**11**	**0**	**75**	**152**
2017-18	Standard	94	140	124	511
	Actual	94	143	189	511
	Saving	**0**	**3**	**65**	**0**
Total Savings		146	203	466	740

Note: Amount has been rounded off to nearest ₹

Table 4.33 reveals that total possible savings in stores and spares for a period of eight years of Bajaj Auto Ltd. might be ₹ 146 crore, Mahindra & Mahindra Ltd. ₹ 203 crore, Maruti Suzuki India Ltd. ₹ 466 crore and lastly Tata Motors Ltd. ₹ 740 crore.

3. Possible Savings in Purchases of Traded Goods of Automobile Sector Companies

Possible savings in this important part has been calculated as under:

Table 4.34

Possible Savings in Purchases of Traded Goods of Automobile Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bajaj Auto Ltd.	Mahindra & Mahindra Ltd.	Maruti Suzuki India Ltd.	Tata Motors Ltd.
2010-11	Standard	568	1757	1278	3669
	Actual	568	1757	1278	7363
	Saving	**0**	**0**	**0**	**3694**
2011-12	Standard	618	2161	1149	3875
	Actual	690	4859	1407	5906
	Saving	**72**	**2698**	**258**	**2031**
2012-13	Standard	601	2608	1317	3122
	Actual	738	8378	1878	5038
	Saving	**137**	**5770**	**561**	**1916**
2013-14	Standard	571	2480	1254	2444
	Actual	783	6591	1984	4121
	Saving	**212**	**4111**	**730**	**1677**
2014-15	Standard	600	2369	1400	2339
	Actual	931	5932	2148	4647
	Saving	**331**	**3563**	**748**	**2308**
2015-16	Standard	666	2579	1681	2899
	Actual	1068	8713	2617	4402
	Saving	**402**	**6134**	**936**	**1503**
2016-17	Standard	634	2776	1986	2884
	Actual	1138	8965	3689	3248
	Saving	**504**	**6189**	**1703**	**364**
2017-18	Standard	712	2959	2256	3805
	Actual	1120	8529	7984	3805
	Saving	**408**	**5570**	**5728**	**0**
Total Savings		2067	34036	10664	13493

Note: Amount has been rounded off to nearest ₹

Table 4.34 highlighted that ₹ 34036 crore would be saved by Mahindra & Mahindra Ltd. if its input is best utilized, Tata Motors Ltd. would have saved ₹ 13493 crore, Maruti Suzuki India Ltd. would have saved ₹ 10664 crore and lastly Bajaj Auto Ltd. would have saved ₹ 2067 crore. The saving would also be possible if the purchases of traded goods should be less, as it is observed that manufactured goods are less expensive as compared to the purchased goods.

4.7.2. Possible Savings in Material Input of Energy Sector Companies

Possible savings have been calculated including its three segments viz., raw material and components, stores and spares and purchases of traded goods. Power Grid Corporation of India Ltd. has been excluded from the calculation of possible savings as there is no material involved in it. It deals in transmission of power.

Table 4.35

Possible Savings in Material Input of Energy Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		GAIL (India) Ltd.	NTPC Ltd.	Oil and Natural Gas Corporation Ltd.
2010-11	Standard	23994	33486	2174
	Actual	23994	35405	2791
	Saving	**0**	**1919**	**617**
2011-12	Standard	27047	34715	2250
	Actual	28644	38262	2250
	Saving	**1597**	**3547**	**0**
2012-13	Standard	30264	34460	2301
	Actual	31493	35274	3607
	Saving	**1229**	**814**	**1306**
2013-14	Standard	34442	35559	2243
	Actual	37881	37435	4184
	Saving	**3439**	**1876**	**1941**
2014-15	Standard	34052	35419	2151
	Actual	36776	39398	3995
	Saving	**2724**	**3979**	**1844**
2015-16	Standard	32518	35004	2145
	Actual	35230	36700	4432
	Saving	**2712**	**1696**	**2287**
2016-17	Standard	29680	38089	2131
	Actual	30199	39199	5014
	Saving	**519**	**1110**	**2883**
2017-18	Standard	31877	39712	2247
	Actual	32632	39712	4487
	Saving	**755**	**0**	**2240**
Total Savings		12976	14942	13119

Note: Amount has been rounded off to nearest ₹

Table 4.35 suggests that the total possible savings in material input for a period of eight years would have been ₹ 12976 crore of GAIL (India) Ltd., ₹ 14942 crore of NTPC Ltd. and ₹ 13119 crore of Oil and Natural Gas Corporation Ltd. Possible savings have been calculated by multiplying the minimum input output ratio with the output of the respective years. The year 2010-11 has been regarded as the base year for GAIL (India) Ltd., the year 2017-18 is regarded as the base year for NTPC Ltd. and the year 2011-12 is consider as a base year for Oil and Natural Gas Corporation Ltd.

1. **Possible Savings in Raw Material and Components of Energy Sector Companies**

It is regarded as very important and essential segment of material input. For analyzing this possible savings has been calculated and results has been analysed.

Table 4.36

Possible Savings in Raw Material and Components of Energy Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		GAIL (India) Ltd.	NTPC Ltd.	Oil and Natural Gas Corporation Ltd.
2010-11	Standard	2023	32550	2174
	Actual	2179	35374	2777
	Saving	**156**	**2824**	**603**
2011-12	Standard	2281	33745	2248
	Actual	2290	38221	2248
	Saving	**9**	**4476**	**0**
2012-13	Standard	2550	33497	2301
	Actual	2550	35235	3604
	Saving	**0**	**1738**	**1303**
2013-14	Standard	2904	34565	2243
	Actual	3952	37397	4182
	Saving	**1048**	**2832**	**1939**
2014-15	Standard	2871	34429	2151
	Actual	4009	39360	3992
	Saving	**1138**	**4931**	**1841**
2015-16	Standard	2742	34025	2145
	Actual	2792	36655	4426
	Saving	**50**	**2630**	**2281**
2016-17	Standard	2503	37024	2131
	Actual	2593	39152	5012
	Saving	**90**	**2128**	**2881**
2017-18	Standard	2688	38604	2247
	Actual	2966	38604	4487
	Saving	**278**	**0**	**2240**
Total Savings		2768	21558	13088

Note: Amount has been rounded off to nearest ₹

Table 4.36 exhibits that the total possible savings in raw material and components for a period of eight years would have been ₹ 2768 crore of GAIL (India) Ltd., ₹ 21558 crore of NTPC Ltd. and ₹ 13088 crore of Oil and Natural Gas Corporation Ltd.

2. **Possible Savings in Stores and Spares of Energy Sector Companies**

Another aspect to discuss here is stores and spares.

Table 4.37

Possible Savings in Stores and Spares of Energy Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		GAIL (India) Ltd.	NTPC Ltd.	Oil and Natural Gas Corporation Ltd.
2010-11	Standard	174	31	0
	Actual	238	31	0
	Saving	**64**	**0**	**0**
2011-12	Standard	196	30	0
	Actual	246	42	0
	Saving	**50**	**12**	**0**
2012-13	Standard	220	30	0
	Actual	255	40	0
	Saving	**35**	**10**	**0**
2013-14	Standard	250	30	0
	Actual	282	39	0
	Saving	**32**	**9**	**0**
2014-15	Standard	247	30	0
	Actual	247	39	0
	Saving	**0**	**9**	**0**
2015-16	Standard	236	30	0
	Actual	258	45	0
	Saving	**22**	**15**	**0**
2016-17	Standard	215	33	0
	Actual	283	47	0
	Saving	**68**	**14**	**0**
2017-18	Standard	231	34	0
	Actual	296	59	0
	Saving	**65**	**25**	**0**
Total Savings		336	94	0

Note: Amount has been rounded off to nearest ₹

Table 4.37 reveals that total possible savings in stores and spares of GAIL (India) Ltd. would have been as high as ₹ 336 crore while it would have been ₹ 94 crore of NTPC Ltd. No stores and spares element is there in the Oil and Natural Gas Corporation Ltd.

3. **Possible Savings in Purchases of Traded Goods of Energy Sector Companies**

Possible savings in this has been depicted here as under:

Table 4.38

Possible Savings in Purchases of Traded Goods of Energy Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		GAIL (India) Ltd.	NTPC Ltd.	Oil and Natural Gas Corporation Ltd.
2010-11	Standard	21576	0	2
	Actual	21576	0	14
	Saving	**0**	**0**	**12**
2011-12	Standard	24322	0	2
	Actual	26108	0	2
	Saving	**1786**	**0**	**0**
2012-13	Standard	27215	0	2
	Actual	28688	0	3
	Saving	**1473**	**0**	**1**
2013-14	Standard	30972	0	2
	Actual	33647	0	3
	Saving	**2675**	**0**	**1**
2014-15	Standard	30621	0	2
	Actual	32521	0	4
	Saving	**1900**	**0**	**2**
2015-16	Standard	29242	0	2
	Actual	32181	0	6
	Saving	**2939**	**0**	**4**
2016-17	Standard	26689	0	2
	Actual	27323	0	2
	Saving	**634**	**0**	**0**
2017-18	Standard	28665	1049	0
	Actual	29370	1049	0
	Saving	**705**	**0**	**0**
Total Savings		12112	0	19

Note: Amount has been rounded off to nearest ₹

Table 4.38 depicts that ₹ 12112 crore would be possible savings of GAIL (India) Ltd., there is no possible savings in case of NTPC Ltd. and ₹ 19 crore would be the possible savings in purchases of traded goods of Oil and Natural Gas Corporation Ltd.

4.7.3. Possible Savings in Material Input of Information Technology Sector Companies

Possible savings in material input of information technology sector companies has three parts which are Raw Material and Components, Stores and Spares and Purchases of Traded Goods. There is no material element in case of Tech Mahindra Ltd. so it has been excluded from the calculation of possible savings.

Table 4.39

Possible Savings in Material Input of Information Technology Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Infosys Ltd.	Tata Consultancy Services Ltd.	Wipro Ltd.
2010-11	Standard	482	9	838
	Actual	482	18	3806
	Saving	**0**	**9**	**2968**
2011-12	Standard	561	11	941
	Actual	596	11	4301
	Saving	**35**	**0**	**3360**
2012-13	Standard	611	13	923
	Actual	649	22	2321
	Saving	**38**	**9**	**1398**
2013-14	Standard	697	17	1024
	Actual	768	32	2080
	Saving	**71**	**15**	**1056**
2014-15	Standard	743	19	1089
	Actual	821	52	2254
	Saving	**78**	**33**	**1165**
2015-16	Standard	868	22	1234
	Actual	901	33	2222
	Saving	**33**	**11**	**988**
2016-17	Standard	934	24	1251
	Actual	1042	1448	1800
	Saving	**108**	**1424**	**549**
2017-18	Standard	959	25	1174
	Actual	1032	1602	1174
	Saving	**73**	**1577**	**0**
Total Savings		437	3078	11484

Note: Amount has been rounded off to nearest ₹

Table 4.39 suggests that the total possible savings in material input would have been ₹ 437 crore of Infosys Ltd, ₹ 3078 crore of Tata Consultancy Services Ltd. and ₹ 11484 crore of Wipro Ltd. For calculating possible savings year of the lowest material input output ratio has been taken as the base year.

1. Possible Savings in Raw Material and Components of Information Technology Sector Companies

The essential chunk of material input is raw material and components. Possible savings in this has been depicted as under.

Table 4.40

Possible Savings in Raw Material and Components of Information Technology Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Infosys Ltd.	Tata Consultancy Services Ltd.	Wipro Ltd.
2010-11	Standard	459	9	3
	Actual	459	18	1086
	Saving	**0**	**9**	**1083**
2011-12	Standard	533	11	3
	Actual	574	11	1329
	Saving	**41**	**0**	**1326**
2012-13	Standard	581	13	3
	Actual	631	21	304
	Saving	**50**	**8**	**301**
2013-14	Standard	662	17	3
	Actual	751	32	168
	Saving	**89**	**15**	**165**
2014-15	Standard	706	19	3
	Actual	789	52	3
	Saving	**83**	**33**	**0**
2015-16	Standard	825	22	0
	Actual	878	33	0
	Saving	**53**	**11**	**0**
2016-17	Standard	888	24	0
	Actual	1016	78	0
	Saving	**128**	**54**	**0**
2017-18	Standard	912	25	0
	Actual	1015	68	0
	Saving	**103**	**43**	**0**
Total Savings		547	173	2875

Note: Amount has been rounded off to nearest ₹

Table 4.40 portrays that Tata Consultancy Services Ltd. would have saved as low as ₹ 173 crore and as high as ₹ 2875 crore of Wipro Ltd. in the raw material and components element of material input for a period of eight years.

2. Possible Savings in Stores and Spares of Information Technology Sector Companies

Possible savings in stores and spares has been presented as below:

Table 4.41

Possible Savings in Stores and Spares of Information Technology Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Infosys Ltd.	Tata Consultancy Services Ltd.	Wipro Ltd.
2010-11	Standard	8	0	23
	Actual	23	0	23
	Saving	**15**	**0**	**0**
2011-12	Standard	9	0	24
	Actual	22	0	26
	Saving	**13**	**0**	**2**
2012-13	Standard	10	0	0
	Actual	19	0	0
	Saving	**9**	**0**	**0**
2013-14	Standard	11	0	26
	Actual	17	0	47
	Saving	**6**	**0**	**21**
2014-15	Standard	12	0	0
	Actual	31	0	0
	Saving	**19**	**0**	**0**
2015-16	Standard	14	0	0
	Actual	23	0	0
	Saving	**9**	**0**	**0**
2016-17	Standard	15	0	0
	Actual	26	0	0
	Saving	**11**	**0**	**0**
2017-18	Standard	16	0	0
	Actual	18	0	0
	Saving	**2**	**0**	**0**
Total Savings		82	0	22

Note: Amount has been rounded off to nearest ₹

Table 4.41 reveals that total possible savings in stores and spares for a period of eight years of Infosys Ltd. could be ₹ 82 crore. There would be no savings in case of Tata Consultancy Ltd. as amount of stores and spares is approximately nil. Calculating total savings of Wipro Ltd. for the study period amounts to ₹ 22 crore.

3. Possible Savings in Purchases of Traded Goods of Information Technology Sector Companies

Purchases of traded good of information technology sector companies has been calculated and shown in the following table.

Table 4.42

Possible Savings in Purchases of Traded Goods of Information Technology Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Infosys Ltd.	Tata Consultancy Services Ltd.	Wipro Ltd.
2010-11	Standard	0	0	838
	Actual	0	0	2697
	Saving	**0**	**0**	**1859**
2011-12	Standard	0	0	941
	Actual	0	0	2945
	Saving	**0**	**0**	**2004**
2012-13	Standard	0	0	923
	Actual	0	0	2016
	Saving	**0**	**0**	**1093**
2013-14	Standard	0	0	1024
	Actual	0	0	1865
	Saving	**0**	**0**	**841**
2014-15	Standard	0	0	1089
	Actual	0	0	2254
	Saving	**0**	**0**	**1165**
2015-16	Standard	0	0	1234
	Actual	0	0	2223
	Saving	**0**	**0**	**989**
2016-17	Standard	0	1369	1251
	Actual	0	1369	1800
	Saving	**0**	**0**	**549**
2017-18	Standard	0	1409	1174
	Actual	0	1534	1174
	Saving	**0**	**125**	**0**
Total Savings		0	125	8500

Note: Amount has been rounded off to nearest ₹

Table 4.42 shows that there is no amount of traded goods in Infosys Ltd., so there is no question of savings. Tata Consultancy Services Ltd. would have saved ₹ 125 crore, Wipro Ltd. ₹ 8500 crore by taking base year as 2016-17 and 2017-18 respectively.

4.7.4. Possible Savings in Material Input of Metals Sector Companies

Metals sector companies can save in its material input if its material input is optimally utilised. This has been elaborated as below:

Table 4.43

Possible Savings in Material Input of Metals Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Coal India Ltd.	Hindalco Ltd.	Tata Steel Ltd.	Vedanta Ltd.
2010-11	Standard	3	13318	7841	1178
	Actual	10	16436	7841	1178
	Saving	**7**	**3118**	**0**	**0**
2011-12	Standard	4	13763	8372	940
	Actual	9	17035	9104	1119
	Saving	**5**	**3272**	**732**	**179**
2012-13	Standard	5	13053	8762	314
	Actual	10	15225	10670	421
	Saving	**5**	**2172**	**1908**	**107**
2013-14	Standard	7	12915	9108	3584
	Actual	10	15748	10316	15610
	Saving	**3**	**2833**	**1208**	**12026**
2014-15	Standard	6	15992	8849	4131
	Actual	14	17484	11826	16486
	Saving	**8**	**1492**	**2977**	**12355**
2015-16	Standard	7	16653	9320	4783
	Actual	9	16653	10979	15695
	Saving	**2**	**0**	**1659**	**10912**
2016-17	Standard	7	16958	11356	5574
	Actual	7	18036	13275	16539
	Saving	**0**	**1078**	**1919**	**10965**
2017-18	Standard	4	19362	13022	5815
	Actual	6	21014	16644	20898
	Saving	**2**	**1652**	**3622**	**15083**
Total Savings		32	15617	14023	61625

Note: Amount has been rounded off to nearest ₹

Table 4.43 demonstrates that the total possible savings in material input for a period of eight years would have been ₹ 32 crore of Coal India Ltd., ₹ 15617 crore of Hindalco Ltd., ₹ 14023 crore of Tata Steel Ltd. and lastly ₹ 61625 crore of Vedanta Ltd. For calculating possible savings year of the lowest material input output ratio has been taken as the base year. The year 2016-17 has been regarded as the base year for Coal India Ltd., 2015-16 for Hindalco Ltd. and 2010-11 for Tata Steel Ltd. and Vedanta Ltd.

1. Possible Savings in Raw Material and Components of Metals Sector Companies

Possible savings in one of the most important raw material and components has been analysed as under:

Table 4.44

Possible Savings in Raw Material and Components of Metals Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Coal India Ltd.	Hindalco Ltd.	Tata Steel Ltd.	Vedanta Ltd.
2010-11	Standard	2	12858	6244	397
	Actual	7	15531	6244	397
	Saving	**5**	**2673**	**0**	**0**
2011-12	Standard	4	13288	6667	317
	Actual	5	16380	7357	525
	Saving	**1**	**3092**	**690**	**208**
2012-13	Standard	4	12602	6977	106
	Actual	7	14720	8485	193
	Saving	**3**	**2118**	**1508**	**87**
2013-14	Standard	5	12470	7253	1208
	Actual	7	15344	7897	14644
	Saving	**2**	**2874**	**644**	**13436**
2014-15	Standard	5	15440	7047	1393
	Actual	11	16971	9413	15193
	Saving	**6**	**1531**	**2366**	**13800**
2015-16	Standard	6	16078	7422	1613
	Actual	6	16078	8119	14366
	Saving	**0**	**0**	**697**	**12753**
2016-17	Standard	5	16373	9043	1880
	Actual	5	17298	10285	15463
	Saving	**0**	**925**	**1242**	**13583**
2017-18	Standard	3	18694	10369	1961
	Actual	4	20300	13485	20142
	Saving	**1**	**1606**	**3116**	**18181**
Total Savings		18	14819	10264	72048

Note: Amount has been rounded off to nearest ₹

Table 4.44 presents the total possible savings in raw material and components of metals sector companies. It would be the highest ₹ 72048 crore of Vedanta Ltd. with base year 2010-11 while the lowest ₹ 18 crore of Coal India Ltd. by taking base year 2015-16 and 2016-17.

2. Possible Savings in Stores and Spares of Metals Sector Companies

Metals sector companies' possible savings in respect of stores and spares is as follows:

Table 4.45

Possible Savings in Stores and Spares of Metals Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Coal India Ltd.	Hindalco Ltd.	Tata Steel Ltd.	Vedanta Ltd.
2010-11	Standard	1	383	1417	84
	Actual	4	383	1417	245
	Saving	**3**	**0**	**0**	**161**
2011-12	Standard	2	396	1512	67
	Actual	3	466	1555	257
	Saving	**1**	**70**	**43**	**190**
2012-13	Standard	2	376	1582	22
	Actual	3	504	1796	137
	Saving	**1**	**128**	**214**	**115**
2013-14	Standard	3	372	1645	255
	Actual	3	403	2131	298
	Saving	**0**	**31**	**486**	**43**
2014-15	Standard	2	460	1598	294
	Actual	2	483	1858	488
	Saving	**0**	**23**	**260**	**194**
2015-16	Standard	3	479	1683	341
	Actual	3	573	2030	454
	Saving	**0**	**94**	**347**	**113**
2016-17	Standard	2	488	2051	397
	Actual	2	665	2265	590
	Saving	**0**	**177**	**214**	**193**
2017-18	Standard	1	557	2351	415
	Actual	1	709	2642	415
	Saving	**0**	**152**	**291**	**0**
Total Savings		5	674	1855	1008

Note: Amount has been rounded off to nearest ₹

Table 4.45 reveals that total possible savings in stores and spares for a period of eight years of Coal India Ltd. might be ₹ 5 crore, Hindalco Ltd. ₹ 674 crore, Tata Steel Ltd. ₹ 1855 crore and total savings of Vedanta Ltd. for the study period amounts to ₹ 1008 crore.

3. Possible Savings in Purchases of Traded Goods of Metals Sector Companies

Possible savings in purchases of traded goods has been analysed as below:

Table 4.46

Possible Savings in Purchases of Traded Goods of Metals Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Coal India Ltd.	Hindalco Ltd.	Tata Steel Ltd.	Vedanta Ltd.
2010-11	Standard	0	2	180	69
	Actual	0	522	180	536
	Saving	**0**	**520**	**0**	**467**
2011-12	Standard	0	2	192	55
	Actual	0	189	192	337
	Saving	**0**	**187**	**0**	**282**
2012-13	Standard	0	0	203	18
	Actual	0	0	389	91
	Saving	**0**	**0**	**186**	**73**
2013-14	Standard	0	0	211	209
	Actual	0	0	288	669
	Saving	**0**	**0**	**77**	**460**
2014-15	Standard	0	3	205	241
	Actual	0	30	555	805
	Saving	**0**	**27**	**350**	**564**
2015-16	Standard	0	1	216	279
	Actual	0	1	830	875
	Saving	**0**	**0**	**614**	**596**
2016-17	Standard	0	3	263	325
	Actual	0	73	725	477
	Saving	**0**	**70**	**462**	**152**
2017-18	Standard	0	4	301	340
	Actual	0	4	517	340
	Saving	**0**	**0**	**216**	**0**
Total Savings		0	803	1906	2594

Note: Amount has been rounded off to nearest ₹

Table 4.46 displays that ₹ 803 crore would be possible savings of Hindalco Ltd., ₹ 1906 crore of Tata Steel Ltd. and ₹ 2594 crore of Vedanta Ltd.

4.7.5. Possible Savings in Material Input of Pharmaceutical Sector Companies

To know the performance of pharmaceutical sector companies in respect of the material an attempt has been made to calculate the possible savings.

Table 4.47

Possible Savings in Material Input of Pharmaceutical Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Cipla Ltd.	Dr. Reddy's Laboratories Ltd.	Lupin Ltd.	Sun Pharmaceutical Industries Ltd.
2010-11	Standard	2362	1517	1425	929
	Actual	3086	1750	1921	929
	Saving	**724**	**233**	**496**	**0**
2011-12	Standard	2454	1750	1524	1105
	Actual	2706	1949	2182	1155
	Saving	**252**	**199**	**658**	**50**
2012-13	Standard	2619	2066	1889	643
	Actual	2955	2381	2512	926
	Saving	**336**	**315**	**623**	**283**
2013-14	Standard	2904	2248	2391	683
	Actual	3266	2248	2630	1032
	Saving	**362**	**0**	**239**	**349**
2014-15	Standard	2998	2334	2485	1939
	Actual	3558	2539	2831	2854
	Saving	**560**	**205**	**346**	**915**
2015-16	Standard	3925	2476	2985	1880
	Actual	4004	2534	3232	2972
	Saving	**79**	**58**	**247**	**1092**
2016-17	Standard	3439	2409	3289	1886
	Actual	3439	2494	3289	3205
	Saving	**0**	**85**	**0**	**1319**
2017-18	Standard	3461	2157	2600	2077
	Actual	3585	2549	3023	3039
	Saving	**124**	**392**	**423**	**962**
Total Savings		2437	1487	3033	4970

Note: Amount has been rounded off to nearest ₹

Table 4.47 suggests that the total possible savings in material input would have been ₹ 2437 crore of Cipla Ltd, ₹ 1487 crore of Dr. Reddy's Laboratories Ltd., ₹ 3033 of Lupin Ltd. and lastly ₹ 4970 crore of Sun Pharmaceutical Industries Ltd. For calculating possible savings year of the lowest material input output ratio has been taken as the base year. The year 2016-17 has been regarded as the base year for Cipla Ltd. and Lupin Ltd. while the year 2013-14 is regarded as the base year for Dr. Reddy's Laboratories Ltd. and 2010-11 is considered as a base year for Sun Pharmaceutical Industries Ltd.

1. Possible Savings in Raw material and Components of Pharmaceutical Sector Companies

The most important share of material input is raw material and components. For analyzing this possible savings has been calculated and results has been analysed.

Table 4.48

Possible Savings in Raw Material and Components of Pharmaceutical Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Cipla Ltd.	Dr. Reddy's Laboratories Ltd.	Lupin Ltd.	Sun Pharmaceutical Industries Ltd.
2010-11	Standard	1671	987	787	718
	Actual	2315	1065	1382	718
	Saving	**644**	**78**	**595**	**0**
2011-12	Standard	1736	1139	841	854
	Actual	2112	1596	1462	874
	Saving	**376**	**457**	**621**	**20**
2012-13	Standard	1852	1345	1043	497
	Actual	2274	1956	1655	606
	Saving	**422**	**611**	**612**	**109**
2013-14	Standard	2054	1463	1320	528
	Actual	2567	1789	1739	730
	Saving	**513**	**326**	**419**	**202**
2014-15	Standard	2120	1519	1372	1499
	Actual	2762	1812	1804	1822
	Saving	**642**	**293**	**432**	**323**
2015-16	Standard	2776	1611	1648	1453
	Actual	3041	1664	1964	1691
	Saving	**265**	**53**	**316**	**238**
2016-17	Standard	2433	1567	1816	1458
	Actual	2433	1567	1816	1834
	Saving	**0**	**0**	**0**	**376**
2017-18	Standard	2448	1404	1436	1606
	Actual	2639	1607	1805	1732
	Saving	**191**	**203**	**369**	**126**
Total Savings		3052	2021	3363	1394

Note: Amount has been rounded off to nearest ₹

Table 4.48 conveys that the total possible savings in raw material and components for a period of eight years could be ₹ 3052 crore of Cipla Ltd., ₹ 2021 crore of Dr. Reddy's Laboratories Ltd., ₹ 3363 crore of Lupin Ltd. and lastly ₹ 1394 crore of Sun Pharmaceutical Industries Ltd. For calculating possible savings year of the lowest raw material and components input output ratio has been taken as the base year. The year 2016-17 has been regarded as the base year for Cipla Ltd., Dr. Reddy's Laboratories Ltd. and Lupin Ltd. For Sun Pharmaceutical Industries Ltd. base year is 2010-11.

2. **Possible Savings in Stores and Spares of Pharmaceutical Sector Companies**

The calculation of possible savings in stores and spares is as follows:

Table 4.49

Possible Savings in Stores and Spares of Pharmaceutical Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Cipla Ltd.	Dr. Reddy's Laboratories Ltd.	Lupin Ltd.	Sun Pharmaceutical Industries Ltd.
2010-11	Standard	53	52	128	34
	Actual	100	353	155	34
	Saving	**47**	**301**	**27**	**0**
2011-12	Standard	55	60	137	40
	Actual	84	70	171	109
	Saving	**29**	**10**	**34**	**69**
2012-13	Standard	59	71	169	24
	Actual	74	87	190	147
	Saving	**15**	**16**	**21**	**123**
2013-14	Standard	65	77	214	25
	Actual	69	77	214	151
	Saving	**4**	**0**	**0**	**126**
2014-15	Standard	67	80	223	71
	Actual	68	303	266	278
	Saving	**1**	**223**	**43**	**207**
2015-16	Standard	88	85	267	69
	Actual	94	359	341	302
	Saving	**6**	**274**	**74**	**233**
2016-17	Standard	77	82	295	69
	Actual	77	374	387	353
	Saving	**0**	**292**	**92**	**284**
2017-18	Standard	78	74	233	76
	Actual	96	406	314	376
	Saving	**18**	**332**	**81**	**300**
Total Savings		120	1449	372	1342

Note: Amount has been rounded off to nearest ₹

Table 4.49 reveals that total possible savings in stores and spares for a period of eight years of Cipla Ltd. would have been ₹ 120 crore, ₹ 1449 crore of Dr. Reddy's Laboratories Ltd., ₹ 372 crore of Lupin Ltd. and lastly ₹ 1342 crore of Sun Pharmaceutical Industries Ltd.

3. **Possible Savings in Purchases of Traded Goods of Pharmaceutical Sector Companies**

Possible savings related to purchases of traded goods have been discussed as below:

Table 4.50

Possible Savings in Purchases of Traded Goods of Pharmaceutical Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Cipla Ltd.	Dr. Reddy's Laboratories Ltd.	Lupin Ltd.	Sun Pharmaceutical Industries Ltd.
2010-11	Standard	491	245	384	145
	Actual	671	331	384	177
	Saving	**180**	**86**	**0**	**32**
2011-12	Standard	510	282	411	172
	Actual	510	282	550	172
	Saving	**0**	**0**	**139**	**0**
2012-13	Standard	544	333	510	100
	Actual	607	338	667	173
	Saving	**63**	**5**	**157**	**73**
2013-14	Standard	603	363	645	106
	Actual	631	383	677	151
	Saving	**28**	**20**	**32**	**45**
2014-15	Standard	623	377	670	302
	Actual	728	424	760	753
	Saving	**105**	**47**	**90**	**451**
2015-16	Standard	815	400	805	292
	Actual	868	511	926	979
	Saving	**53**	**111**	**121**	**687**
2016-17	Standard	715	389	887	293
	Actual	929	553	1087	1018
	Saving	**214**	**164**	**200**	**725**
2017-18	Standard	719	348	701	323
	Actual	850	537	903	932
	Saving	**131**	**189**	**202**	**609**
Total Savings		774	622	939	2621

Note: Amount has been rounded off to nearest ₹

Table 4.50 depicts Sun Pharmaceutical Industries Ltd. could save ₹ 2621, Lupin Ltd. ₹ 939 crore, Cipla Ltd. ₹ 774 crore and Dr. Reddy's Laboratories Ltd. ₹ 622 crore if it utilised resources perfectly.

4.7.6. Possible Savings in Material Input of Refineries Sector Companies

To understand the savings of refineries sector companies in respect of the material input and its segments such as raw material and components, stores and spares and purchases of traded goods, possible savings has been calculated. This is shown in the table below.

Table 4.51

Possible Savings in Material Input of Refineries Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bharat Petroleum Corporation Ltd.	Hindustan Petroleum Corporation Ltd.	Indian Oil Corporation Ltd.	Reliance Industries Ltd.
2010-11	Standard	127605	114045	260459	163790
	Actual	141028	126019	299786	198076
	Saving	**13423**	**11974**	**39327**	**34286**
2011-12	Standard	165029	142246	318399	203259
	Actual	181706	152954	362046	256799
	Saving	**16677**	**10708**	**43647**	**53540**
2012-13	Standard	174172	155542	305154	207077
	Actual	192016	164658	351690	266658
	Saving	**17844**	**9116**	**46536**	**59581**
2013-14	Standard	178654	158405	309459	215299
	Actual	196106	169305	346723	272775
	Saving	**17452**	**10900**	**37264**	**57476**
2014-15	Standard	166470	148357	289216	180865
	Actual	170667	149845	310164	215874
	Saving	**4197**	**1488**	**20948**	**35009**
2015-16	Standard	135606	131401	237967	135406
	Actual	135606	131401	240796	135406
	Saving	**0**	**0**	**2829**	**0**
2016-17	Standard	138341	131488	229015	133666
	Actual	149883	138400	247462	143569
	Saving	**11542**	**6912**	**18447**	**9903**
2017-18	Standard	161548	153937	273895	155699
	Actual	165480	154915	273895	168328
	Saving	**3932**	**978**	**0**	**12629**
Total Savings		85067	52075	208996	262423

Note: Amount has been rounded off to nearest ₹

Table 4.51 portrays the total possible savings in material input for a period of eight years would have been ₹ 85067 crore of Bharat Petroleum Corporation Ltd., ₹ 52075 crore of Hindustan Petroleum Corporation Ltd., ₹ 208996 crore of Indian Oil Corporation Ltd. and lastly ₹ 262423 crore of Reliance Industries Ltd. For calculating possible savings year of the lowest material input output ratio has been taken as the base year. The year 2015-16 has been regarded as the base year for Bharat Petroleum Corporation Ltd., Hindustan Petroleum Corporation Ltd. and Reliance Industries Ltd. For Indian Oil Corporation Ltd. base year is 2017-18.

1. **Possible Savings in Raw Material and Components of Refineries Sector Companies**

The essential segment of material input is raw material and components. For analyzing this possible savings has been calculated and results has been analysed.

Table 4.52

Possible Savings in Raw Material and Components of Refineries Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bharat Petroleum Corporation Ltd.	Hindustan Petroleum Corporation Ltd.	Indian Oil Corporation Ltd.	Reliance Industries Ltd.
2010-11	Standard	48201	29645	130752	154689
	Actual	62870	40505	143241	193234
	Saving	**14669**	**10860**	**12489**	**38545**
2011-12	Standard	62338	36975	159838	191965
	Actual	78690	52441	186045	252279
	Saving	**16352**	**15466**	**26207**	**60314**
2012-13	Standard	65792	40431	153189	195571
	Actual	83880	54431	189138	262963
	Saving	**18088**	**14000**	**35949**	**67392**
2013-14	Standard	67485	41176	155350	203336
	Actual	89240	50735	185615	268719
	Saving	**21755**	**9559**	**30265**	**65383**
2014-15	Standard	62882	38564	145188	170815
	Actual	76227	45450	165855	206334
	Saving	**13345**	**6886**	**20667**	**35519**
2015-16	Standard	51225	34159	119448	127868
	Actual	51225	34159	119448	127868
	Saving	**0**	**0**	**0**	**0**
2016-17	Standard	52257	34179	114967	126239
	Actual	55870	37148	129524	135178
	Saving	**3613**	**2969**	**14557**	**8939**
2017-18	Standard	61023	40014	137495	147048
	Actual	65235	40898	151159	158225
	Saving	**4212**	**884**	**13664**	**11177**
Total Savings		92033	60625	153796	287268

Note: Amount has been rounded off to nearest ₹

Table 4.52 manifests that the total possible savings in raw material and components element of material input for a period of eight years would have been ₹ 92033 crore of Bharat Petroleum Corporation Ltd., ₹ 60625 crore of Hindustan Petroleum Corporation Ltd., ₹ 153796 crore of Indian Oil Corporation Ltd. and lastly ₹ 287268 crore of Reliance Industries Ltd. For calculating possible savings

year of the lowest raw material and components input output ratio has been taken as the base year. The year 2015-16 has been regarded as the base year for all the companies.

2. **Possible Savings in Stores and Spares of Refineries Sector Companies**

The second segment of material input is stores and spares. Its possible savings has been stated below:

Table 4.53

Possible Savings in Stores and Spares of Refineries Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bharat Petroleum Corporation Ltd.	Hindustan Petroleum Corporation Ltd.	Indian Oil Corporation Ltd.	Reliance Industries Ltd.
2010-11	Standard	15	92	686	2579
	Actual	53	117	834	3378
	Saving	**38**	**25**	**148**	**799**
2011-12	Standard	20	111	824	3196
	Actual	54	111	824	3196
	Saving	**34**	**0**	**0**	**0**
2012-13	Standard	21	134	803	3263
	Actual	57	134	904	3263
	Saving	**36**	**0**	**101**	**0**
2013-14	Standard	21	128	815	3390
	Actual	53	137	979	3628
	Saving	**32**	**9**	**164**	**238**
2014-15	Standard	20	120	761	2848
	Actual	96	197	1217	3790
	Saving	**76**	**77**	**456**	**942**
2015-16	Standard	16	106	627	2132
	Actual	68	193	1131	3988
	Saving	**52**	**87**	**504**	**1856**
2016-17	Standard	9	106	603	2105
	Actual	9	244	1133	4144
	Saving	**0**	**138**	**530**	**2039**
2017-18	Standard	0	124	721	2452
	Actual	0	195	1195	4295
	Saving	**0**	**71**	**474**	**1843**
Total Savings		269	407	2377	7718

Note: Amount has been rounded off to nearest ₹

Table 4.53 displays that the total possible savings in stores and spares for a period of eight years of Bharat Petroleum Corporation Ltd. might be ₹ 269 crore, Hindustan Petroleum Corporation Ltd. ₹ 407 crore, Indian Oil Corporation Ltd. ₹ 2377 crore and lastly Reliance Industries Ltd. ₹ 7718 crore.

3. **Possible Savings in Purchases of Traded Goods of Refineries Sector Companies**

The next segment is the purchases of traded goods. For analyzing this possible savings has been calculated and results has been analysed.

Table 4.54

Possible Savings in Purchases of Traded Goods of Refineries Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bharat Petroleum Corporation Ltd.	Hindustan Petroleum Corporation Ltd.	Indian Oil Corporation Ltd.	Reliance Industries Ltd.
2010-11	Standard	72325	80104	115567	322
	Actual	78105	85397	155711	1464
	Saving	**5780**	**5293**	**40144**	**1142**
2011-12	Standard	93536	99912	141276	400
	Actual	102962	100402	175177	1323
	Saving	**9426**	**490**	**33901**	**923**
2012-13	Standard	98719	109250	135399	408
	Actual	108079	110093	161649	431
	Saving	**9360**	**843**	**26250**	**23**
2013-14	Standard	101259	111262	137309	428
	Actual	106813	118433	160130	428
	Saving	**5554**	**7171**	**22821**	**0**
2014-15	Standard	94344	104198	128327	356
	Actual	94344	104198	143092	5750
	Saving	**0**	**0**	**14765**	**5394**
2015-16	Standard	76865	92295	105588	266
	Actual	84313	97049	120217	3550
	Saving	**7448**	**4754**	**14629**	**3284**
2016-17	Standard	78410	92355	101616	263
	Actual	94003	101008	116805	4248
	Saving	**15593**	**8653**	**15189**	**3985**
2017-18	Standard	91564	108123	121542	306
	Actual	100245	113822	121542	5807
	Saving	**8681**	**5699**	**0**	**5501**
Total Savings		61842	32903	167700	20251

Note: Amount has been rounded off to nearest ₹

Table 4.54 portrays that ₹ 167700 crore would be possible savings of Indian Oil Corporation Ltd., ₹ 61842 crore of Bharat Petroleum Corporation Ltd., ₹ 32903 crore of Hindustan Petroleum Corporation Ltd. and lastly ₹ 20251 crore of Reliance Industries Ltd. if its input is properly utilized.

4.8. Comparative Analysis of Average Material Productivity Ratios

To analyse between the companies of a particular sector it is better to analyse its average performance for the study period. In the present study an attempt has been made to analyse and interpret the results on the basis of average performance.

Table 4.55

Comparative Analysis of Average Material Productivity Ratios of Automobile Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Raw Material and Components (Input Output Ratio)		Stores and Spares (Input Output Ratio)		Purchases of Traded Goods (Input Output Ratio)		Total Material (Input Output Ratio)		Material Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
Bajaj Auto Ltd.	0.6367	3	0.0054	3	0.0472	1	0.6893	1	1.4529	1	0.273	1
Mahindra & Mahindra Ltd	0.5198	1	0.0044	2	0.1958	4	0.7200	4	1.3907	4	0.660	3
Maruti Suzuki India Ltd.	0.6531	4	0.0032	1	0.0592	2	0.7155	2	1.4020	2	0.292	2
Tata Motors Ltd.	0.5842	2	0.0127	4	0.1212	3	0.7181	3	1.3954	3	1.212	4

Raw Material and Components Average Input Output Ratio: The raw material and components average input output ratio is the best of Mahindra & Mahindra Ltd. by 0.5198, followed by Tata Motors Ltd. by 0.5842, Bajaj Auto Ltd. by 0.6367 and lastly Maruti Suzuki India Ltd. by 0.6531.

Stores and Spares Average Input Output Ratio: Stores and spares average input output ratio is the best of Maruti Suzuki India Ltd. as compared to Bajaj Auto Ltd., Mahindra & Mahindra Ltd. and Tata Motors Ltd.

Purchase of Traded Goods Average Input Output Ratio: Purchase of traded goods average input output ratio is 0.0472 of Bajaj Auto Ltd., 0.0592 of Maruti Suzuki India Ltd., 0.1212 of Tata Motors Ltd. and 0.1958 of Mahindra & Mahindra Ltd.

Total Material Average Input Output Ratio: The total material average input output ratio is the best of Bajaj Auto Ltd. with 0.6893, followed by Maruti Suzuki India Ltd. with 0.7155, Tata Motors Ltd. with 0.7181 and Mahindra & Mahindra Ltd. with 0.7200.

Average Material Productivity Ratio: Average material productivity ratio is the best of Bajaj Auto Ltd. with 1.4529 which means that for one ₹ of material input, the output produced is ₹ 1.4529. This is followed by Maruti Suzuki India Ltd.

with 1.4020 then Tata Motors Ltd. with 1.3954 and lastly Mahindra & Mahindra Ltd. with 1.3907.

Chi-square Test: On analysing the chi-square of the automobile sector companies included in Nifty 50 it has been observed that Bajaj Auto Ltd. has the least chi-square value with 0.273 then the Maruti Suzuki India Ltd. with 0.292, followed by Mahindra & Mahindra Ltd. with 0.660 and lastly it is Tata Motors Ltd. with the highest chi-square value 1.212. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square is accepted in all the above cases. This means that the alternative hypothesis is rejected. This reveals that the material productivity ratios of all the companies of automobile sector of Nifty 50 for the eight years period are approximately the same.

Table 4.56

Comparative Analysis of Average Material Productivity Ratios of Energy Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Raw Material and Components (Input Output Ratio)		Stores and Spares (Input Output Ratio)		Purchases of Traded Goods (Input Output Ratio)		Total Material (Input Output Ratio)		Material Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
GAIL (India) Ltd.	0.0693	2	0.0064	2	0.6918	3	0.7674	3	1.3044	3	0.769	2
NTPC Ltd.	0.6117	3	0.0007	1	0.0019	2	0.6144	2	1.6296	2	0.684	1
Oil and Natural Gas Corporation Ltd.	0.0529	1	-	-	0.0001	1	0.0530	1	20.2175	1	17.257	3

Raw Material and Components Average Input Output Ratio: The raw material and components average input output ratio is the best of Oil and Natural Gas Corporation Ltd. by 0.0529, followed by GAIL (India) Ltd. by 0.0693 and lastly NTPC Ltd. by 0.6117.

Stores and Spares Average Input Output Ratio: Stores and spares average input output ratio is not available for Oil and Natural Gas Corporation Ltd. It is the best of NTPC Ltd. with 0.0007 as compared to GAIL (India) Ltd. with 0.0064.

Purchase of Traded Goods Average Input Output Ratio: Purchase of traded goods average input output ratio is 0.0001 of Oil and Natural Gas Corporation Ltd., 0.0019 of NTPC Ltd. and 0.6918 of GAIL (India) Ltd.

Total Material Average Input Output Ratio: The total material average input output ratio is the best of Oil and Natural Gas Corporation Ltd. with 0.0530, followed by NTPC Ltd. with 0.6144 and GAIL (India) Ltd. with 0.7674.

Average Material Productivity Ratio: Average material productivity ratio is the best of Oil and Natural Gas Corporation Ltd. with 20.2175 which means that for one ₹ of material input, the output produced is approximately ₹ 20. This is followed by NTPC Ltd. with 1.6296 and lastly GAIL (India) Ltd. with 1.3044.

Chi-square Test: On analysing the chi-square of the energy sector companies included in Nifty 50 it has been observed that NTPC Ltd. has the least chi-square value with 0.684 then the GAIL (India) Ltd. with 0.769 and lastly it is Oil and Natural Gas Corporation Ltd. with the highest chi-square value 17.257. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square is accepted in GAIL (India) Ltd. and NTPC Ltd. while it is rejected in case of Oil and Natural Gas Corporation Ltd.

Table 4.57

Comparative Analysis of Average Material Productivity Ratios of Information Technology Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Raw Material and Components (Input Output Ratio)		Stores and Spares (Input Output Ratio)		Purchases of Traded Goods (Input Output Ratio)		Total Material (Input Output Ratio)		Material Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
Infosys Ltd.	0.0189	3	0.0006	2	-	-	0.0195	2	51.4073	2	0.622	1
Tata Consultancy Services Ltd.	0.0006	1	-	-	0.0045	1	0.0051	1	1560.5800	1	190.885	3
Wipro Ltd.	0.0125	2	0.0004	1	0.0648	2	0.0776	3	16.3281	3	40.609	2

Raw Material and Components Average Input Output Ratio: The raw material and components average input output ratio of Infosys Ltd. is 0.0189, Tata Consultancy Services Ltd. is 0.0006 and lastly Wipro Ltd. is 0.0125. Tata Consultancy Services Ltd. has reported the best raw material and components input output ratio.

Stores and Spares Average Input Output Ratio: Stores and spares average input output ratio is the best of Wipro Ltd. with 0.0004 as compared to Infosys Ltd. with 0.0006 while it is zero of Tata Consultancy Services Ltd.

Purchase of Traded Goods Average Input Output Ratio: Purchase of traded goods average input output ratio is the best of Tata Consultancy Services Ltd. as compared to others.

Total Material Average Input Output Ratio: The total material average input output ratio is the best of Tata Consultancy Services Ltd., followed by Infosys Ltd. and Wipro Ltd.

Average Material Productivity Ratio: Average material productivity ratio is the best of Tata Consultancy Services Ltd. with 1560.5800, followed by Infosys Ltd. with 51.4073 and Wipro Ltd. with 16.3281.

Chi-square Test: On observing the chi-square of the information technology sector companies included in Nifty 50 it has been concluded that Infosys Ltd. has the least chi-square value with 0.622, Wipro Ltd. with 40.609 and lastly Tata Consultancy Services Ltd. with the highest chi-square value 190.885. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square is accepted in case of Infosys Ltd. while null hypothesis is rejected in case of Tata Consultancy Services Ltd. and Wipro Ltd.

Table 4.58

Comparative Analysis of Average Material Productivity Ratios of Metals Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Raw Material and Components (Input Output Ratio)		Stores and Spares (Input Output Ratio)		Purchases of Traded Goods (Input Output Ratio)		Total Material (Input Output Ratio)		Material Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
Coal India Ltd.	0.0007	1	0.0003	1	-	-	0.0010	1	1209.8458	1	67.489	4
Hindalco Ltd.	0.6129	4	0.0191	2	0.0042	1	0.6362	4	1.5802	4	1.636	1
Tata Steel Ltd.	0.2434	2	0.0539	4	0.0124	2	0.3097	2	3.2526	3	2.593	2
Vedanta Ltd.	0.3411	3	0.0256	3	0.0334	3	0.4001	3	3.3815	2	53.572	3

Raw Material and Components Average Input Output Ratio: The raw material and components average input output ratio is the best of Coal India Ltd. with 0.0007, followed by Tata Steel Ltd. with 0.2434, Vedanta Ltd. with 0.3411 and lastly Hindalco Ltd. with 0.6129.

Stores and Spares Average Input Output Ratio: Stores and spares average input output ratio is the best of Coal India Ltd. with 0.0003, as compared to

Hindalco Ltd. with 0.0191, Vedanta Ltd. with 0.0256 followed by Tata Steel Ltd. with 0.0539.

Purchase of Traded Goods Average Input Output Ratio: Purchase of traded goods average input output ratio is the best Hindalco Ltd. as compared to others.

Total Material Average Input Output Ratio: The total material average input output ratio is the best of Coal India Ltd. with 0.0010, followed by Tata Steel Ltd. with 0.3097, Vedanta Ltd. with 0.4001 and Hindalco Ltd. with 0.6362.

Average Material Productivity Ratio: Average material productivity ratio is the best of Coal India Ltd. with 1209.8458, followed by Vedanta Ltd. with 3.3815, Tata Steel Ltd. with 3.2526 and Hindalco Ltd. with 1.5802.

Chi-square Test: On analysing the chi-square of the metals sector companies included in Nifty 50 it has been observed that Hindalco Ltd. has the least chi-square value with 1.636 then the Tata Steel Ltd. with 2.593, Vedanta Ltd. with 53.572 and lastly it is Coal India Ltd. with the highest chi-square value 67.489. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square has been accepted in case of Hindalco Ltd. and Tata Steel Ltd. while it is rejected in the other cases.

Table 4.59

Comparative Analysis of Average Material Productivity Ratios of Pharmaceutical Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Raw Material and Components (Input Output Ratio)		Stores and Spares (Input Output Ratio)		Purchases of Traded Goods (Input Output Ratio)		Total Material (Input Output Ratio)		Material Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
Cipla Ltd.	0.3164	4	0.0105	1	0.0899	2	0.4169	4	2.4152	4	2.365	1
Dr. Reddy's Laboratories Ltd	0.2200	1	0.0343	2	0.0560	1	0.3103	1	3.2333	1	2.752	2
Lupin Ltd.	0.2433	2	0.0344	3	0.1011	4	0.3788	2	2.6766	2	4.469	3
Sun Pharmaceutical Industries Ltd.	0.2541	3	0.0442	4	0.0962	3	0.3945	3	2.6187	3	7.936	4

Raw Material and Components Average Input Output Ratio: The raw material and components average input output ratio of Cipla Ltd. is 0.3164, Dr. Reddy's Laboratories Ltd. is 0.2200, Lupin Ltd. is 0.2433 and lastly Sun Pharmaceutical Industries Ltd. is 0.2541. Dr. Reddy's Laboratories Ltd. has reported the best raw material and components input output ratio.

Stores and Spares Average Input Output Ratio: Stores and spares average input output ratio is the best of Cipla Ltd. with 0.0105 as compared to Dr. Reddy's Laboratories Ltd. with 0.0343, Lupin Ltd. with 0.0344, Sun Pharmaceutical Industries Ltd. with 0.0442.

Purchase of Traded Goods Average Input Output Ratio: Purchase of traded goods average input output ratio is the best of Dr. Reddy's Laboratories Ltd. as compared to others.

Total Material Average Input Output Ratio: The total material average input output ratio is the best of Dr. Reddy's Laboratories Ltd., followed by Lupin Ltd., Sun Pharmaceutical Industries Ltd. and Cipla Ltd.

Average Material Productivity Ratio: Average material productivity ratio is the best of Dr. Reddy's Laboratories Ltd. with 3.2333, followed by Lupin Ltd. with 2.6766, Sun Pharmaceutical Industries Ltd. with 2.6187 and lastly Cipla Ltd. with 2.4152.

Chi-square Test: On observing the chi-square of the pharmaceutical sector companies included in Nifty 50 it has been concluded that Cipla Ltd. has the least chi-square value with 2.365, Dr. Reddy's Laboratories Ltd. with 2.752, Lupin Ltd. with 4.469 and lastly Sun Pharmaceutical Industries Ltd. with the highest chi-square value 7.936. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square is accepted in all the above cases and indicates that the material productivity ratios of all the companies of pharmaceutical sector of Nifty 50 for the eight years period are approximately the same.

Table 4.60

Comparative Analysis of Average Material Productivity Ratios of Refineries Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Raw Material and Components (Input Output Ratio)		Stores and Spares (Input Output Ratio)		Purchases of Traded Goods (Input Output Ratio)		Total Material (Input Output Ratio)		Material Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
Bharat Pertroleum Corporation Ltd.	0.3790	2	0.0003	1	0.5213	3	0.9006	3	1.1120	3	0.650	3
Hindustan Pertroleum Corporation Ltd.	0.2721	1	0.0010	2	0.6356	4	0.9088	4	1.1017	4	0.353	1
Indian Oil Corporation Ltd.	0.4533	3	0.0030	3	0.4136	2	0.8700	2	1.1526	2	0.575	2
Reliance Industries Ltd.	0.7473	4	0.0147	4	0.0121	1	0.7741	1	1.3017	1	2.918	4

Raw Material and Components Average Input Output Ratio: The raw material and components average input output ratio is the best of Hindustan Petroleum Corporation Ltd. with 0.2721, followed by Bharat Petroleum Corporation Ltd. with 0.3790, Indian Oil Corporation Ltd. with 0.4533 and lastly Reliance Industries Ltd. with 0.7473.

Stores and Spares Average Input Output Ratio: Stores and spares average input output ratio is the best of Bharat Petroleum Corporation Ltd. with 0.0003 as compared to Hindustan Petroleum Corporation Ltd. with 0.0010, followed by Indian Oil corporation Ltd. with 0.0030 and Reliance Industries Ltd. with 0.0147.

Purchase of Traded Goods Average Input Output Ratio: Purchase of traded goods average input output ratio is the best of Reliance Industries Ltd. as compared to others.

Total Material Average Input Output Ratio: The total material average input output ratio is the best of Reliance Industries Ltd. with 0.7741, followed by Indian Oil Corporation Ltd. with 0.8700, Bharat Petroleum Corporation Ltd. with 0.9006 and Hindustan Petroleum Corporation Ltd. with 0.9088.

Average Material Productivity Ratio: Average material productivity ratio is the best of Reliance Industries Ltd. with 1.3017 which means that for every one ₹ of material input, the output produced is approximately ₹ 1.3017. This is followed by Indian Oil Corporation Ltd. with 1.1526, Bharat Petroleum Corporation Ltd. with 1.1120 and Hindustan Petroleum Corporation Ltd. with 1.1017.

Chi-square Test: On analysing the Chi-square of the Refineries Sector Companies included in Nifty 50 it has been observed that Hindustan Petroleum Corporation Ltd. has the least chi-square value with 0.353 then the Indian Oil Corporation Ltd. with 0.575, Bharat Petroleum Corporation Ltd. with 0.650 and lastly it is Reliance Industries Ltd. with the highest chi-square value 2.918. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square has been accepted in all the companies taken under the present study.

4.9. Concluding Observations

Productivity is calculated taking material, labour and overhead as input. This chapter deals with only the material element. As per the study, material expenses

are broadly divided into the three parts, viz., raw material and components, stores and spares and purchases of traded goods. Measurement of material productivity is undertaken in four steps, viz., revaluation of material input at base year prices, computation and analysis of material productivity ratios and material productivity indices, testing hypotheses and computation of possible savings. On analysing the average material productivity of eight years from 2010-11 to 2017-18, it is the best of Coal India Ltd. in automobile sector, NTPC Ltd. in energy sector where Tech Mahindra Ltd. has been excluded from the calculation. Infosys Ltd. is the best in information technology sector where Power Grid Corporation of India Ltd. has been excluded from the calculation. Coal India Ltd. has the highest material productivity in metals sector, Dr. Reddy's Laboratories Ltd. in Pharmaceutical sector and Reliance Industries Ltd. in refineries sector.

Second aspect of productivity has been explained in the next chapter i.e. labour. Only expenses directly related to labour or manpower has been considered there.

Appendices

Appendix 4.1 to 4.4. Revaluation of Material Input of Automobile Sector Companies

Appendix 4.1

Revaluation of Material Input of Bajaj Auto Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**															
1	Raw Material Consumed	11311.89	13445.54	12343.01	13523.74	11616.89	12936.47	10556.16	13752.79	11084.75	13717.01	11481.14	13285.36	10933.85	15999.16	12783.33
2	Packing Material Consumed	210.09	273.30	250.89	255.41	219.40	268.65	219.22	312.80	252.12	309.38	258.95	244.85	201.51	269.18	215.07
	Total (A)	11521.98	13718.84	12593.90	13779.15	11836.29	13205.12	10775.38	14065.59	11336.87	14026.39	11740.09	13530.21	11135.36	16268.34	12998.40
(B)	**Stores and Spares Consumed**	85.00	110.25	101.21	123.85	106.39	124.98	101.98	131.69	106.14	131.80	110.32	114.63	94.34	117.71	94.05
(C)	**Purchases of Traded Goods**	568.41	751.15	689.56	858.83	737.73	959.10	782.63	1154.57	930.58	1276.40	1068.35	1382.47	1137.77	1401.25	1119.60
	Total Material Input (A+B+C)	12175.39	14580.24	13384.66	14761.83	12680.41	14289.20	11659.99	15351.85	12373.59	15434.59	12918.75	15027.31	12367.48	17787.30	14212.05

Appendix 4.2

Revaluation of Material Input of Mahindra & Mahindra Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**	14708.94	18804.52	17262.55	20749.87	17824.14	21630.08	17650.15	20272.48	16339.62	19373.16	16215.33	21129.65	17389.70	23265.31	18588.98
(B)	**Stores and Spares Consumed**	138.71	161.84	148.57	172.72	148.37	182.44	148.87	179.79	144.91	153.05	128.10	161.29	132.74	179.99	143.81
(C)	**Purchase of Traded Goods**	1757.23	5292.58	4858.59	9752.68	8377.55	8076.92	6590.77	7359.37	5931.65	10409.26	8712.55	10893.63	8965.46	10674.47	8528.90
	Total Material Input (A+B+C)	16604.88	24258.94	22269.71	30675.27	26350.06	29889.44	24389.78	27811.64	22416.18	29935.47	25055.99	32184.57	26487.90	34119.77	27261.70

Appendix 4.3

Revaluation of Material Input of Maruti Suzuki India Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**	27141.80	26707.00	24517.03	30349.20	26069.96	28898.90	23581.50	32867.80	26491.45	35706.90	29886.68	42629.60	35084.16	44941.30	35908.10
(B)	**Stores and Spares Consumed**	70.20	91.10	83.63	186.40	160.12	164.70	134.40	180.10	145.16	214.00	179.12	224.10	184.43	236.20	188.72
(C)	**Purchases of Traded Goods**	1278.10	1532.50	1406.84	2186.40	1878.12	2431.40	1984.02	2665.20	2148.15	3126.40	2616.80	4482.10	3688.77	9993.00	7984.41
	Total Material Input (A+B+C)	28490.10	28330.60	26007.49	32722.00	28108.20	31495.00	25699.92	35713.10	28784.76	39047.30	32682.59	47335.80	38957.36	55170.50	44081.23

Appendix 4.4

Revaluation of Material Input of Tata Motors Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**	27058.47	33894.82	31115.44	27244.28	23402.84	20492.87	16722.18	22155.23	17857.12	24313.08	20350.05	27651.65	22757.31	37080.45	29627.28
(B)	**Stores and Spares Consumed**	625.45	753.02	691.27	655.67	563.22	497.90	406.29	447.36	360.57	470.94	394.18	653.61	537.92	639.35	510.84
(C)	**Purchase of Traded Goods**	7363.13	6433.95	5906.37	5864.45	5037.56	5049.82	4120.65	5765.24	4646.78	5259.27	4402.01	3945.97	3247.53	4762.41	3805.17
	Total Material Input (A+B+C)	35047.05	41081.79	37713.08	33764.40	29003.62	26040.59	21249.12	28367.83	22864.47	30043.29	25146.23	32251.23	26542.76	42482.21	33943.29

Appendix 4.5 to 4.8. Revaluation of Material Input of Energy Sector Companies

Appendix 4.5

Revaluation of Material Input of GAIL (India) Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**	2178.78	2494.10	2289.58	2968.68	2550.10	4843.43	3952.24	4973.98	4009.03	3335.16	2791.53	3151.24	2593.47	3712.42	2966.22
(B)	**Stores and Spares Consumed**	238.38	268.14	246.15	297.34	255.42	345.56	281.98	306.64	247.15	307.93	257.74	343.44	282.65	370.47	296.01
(C)	**Purchases of Traded Goods**	21576.97	28440.46	26108.34	33396.89	28687.93	41234.42	33647.29	40348.33	32520.75	38447.97	32180.95	33199.67	27323.33	36758.58	29370.11
	Total Material Input (A+B+C)	23994.13	31202.70	28644.08	36662.91	31493.44	46423.41	37881.50	45628.95	36776.93	42091.06	35230.22	36694.35	30199.45	40841.47	32632.33

Appendix 4.6

Revaluation of Material Input of NTPC Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**	35373.78	41635.46	38221.35	41018.25	35234.68	45829.71	37397.04	48833.57	39359.86	43793.25	36654.95	47572.19	39151.91	48315.47	38604.06
(B)	**Stores and Spares Consumed**	31.33	45.24	41.53	46.35	39.81	47.60	38.84	48.34	38.96	53.89	45.11	57.48	47.31	73.61	58.81
(C)	**Purchases of Traded Goods**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1313.51	1049.49
	Total Material Input (A+B+C)	35405.11	41680.70	38262.88	41064.60	35274.49	45877.31	37435.88	48881.91	39398.82	43847.14	36700.06	47629.67	39199.22	49702.59	39712.37

Appendix 4.7

Revaluation of Material Input of Oil and Natural Gas Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**	2776.85	2448.50	2247.72	4196.05	3604.41	5124.66	4181.72	4952.66	3991.84	5288.40	4426.39	6090.27	5012.29	5615.87	4487.08
(B)	**Purchases of Traded Goods**	13.83	2.48	2.28	3.10	2.66	3.18	2.59	4.41	3.55	7.15	5.98	2.60	2.14	0.00	0.00
	Total Material Input (A+B)	2790.68	2450.98	2250.00	4199.15	3607.07	5127.84	4184.32	4957.07	3995.40	5295.55	4432.38	6092.87	5014.43	5615.87	4487.08

Appendix 4.8

Revaluation of Material Input of Power Grid Corporation of India Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Stores and Spares Consumed**	0.03	0.05	0.05	0.09	0.08	0.06	0.05	1.02	0.82	4.59	3.84	3.92	3.23	8.67	6.93
(B)	**Purchases of Traded Goods**	0.00	0.00	0.00	63.50	54.55	219.40	179.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total Material Input (A+B)	0.03	0.05	0.05	63.59	54.62	219.46	179.08	1.02	0.82	4.59	3.84	3.92	3.23	8.67	6.93

Appendix 4.9 to 4.12 Revaluation of Material Input of Information Technology Sector Companies

Appendix 4.9

Revaluation of Material Input of Infosys Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**	459.00	625.00	573.75	734.00	630.51	920.00	750.72	979.00	789.07	1049.00	878.01	1235.00	1016.41	1270.00	1014.73
(B)	**Stores and Spares Consumed**	23.00	24.00	22.03	22.00	18.90	21.00	17.14	39.00	31.43	28.00	23.44	31.00	25.51	22.00	17.58
	Total Material Input (A+B)	482.00	649.00	595.78	756.00	649.40	941.00	767.86	1018.00	820.51	1077.00	901.45	1266.00	1041.92	1292.00	1032.31

Appendix 4.10

Revaluation of Material Input of Tata Consultancy Services Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**	17.71	11.78	10.81	25.02	21.49	39.77	32.45	64.62	52.08	39.09	32.72	95.00	78.19	85.00	67.92
(B)	**Stores and Spares Consumed**	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.06	0.05	0.74	0.62	0.00	0.00	0.00	0.00
(C)	**Purchases of Traded Goods**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1664.00	1369.47	1920.00	1534.08
	Total Material Input (A+B+C)	17.75	11.81	10.84	25.04	21.51	39.79	32.47	64.68	52.13	39.83	33.34	1759.00	1447.66	2005.00	1602.00

Appendix 4.11

Revaluation of Material Input of Tech Mahindra Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**	1.50	0.50	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total Material Input (A)	1.50	0.50	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix 4.12

Revaluation of Material Input of Wipro Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**	1085.70	1447.50	1328.81	354.20	304.26	205.30	167.52	3.40	2.74	0.20	0.17	0.00	0.00	0.00	0.00
(B)	**Stores and Spares Consumed**	22.70	28.80	26.44	0.00	0.00	57.40	46.84	-2.80	-2.26	-1.20	-1.00	0.00	0.00	0.00	0.00
(C)	**Purchases of Traded Goods**	2697.20	3208.60	2945.49	2347.20	2016.24	2285.80	1865.21	2796.40	2253.90	2655.50	2222.65	2186.90	1799.82	1469.60	1174.21
	Total Material Input (A+B+C)	3805.60	4684.90	4300.74	2701.40	2320.50	2548.50	2079.58	2797.00	2254.38	2654.50	2221.82	2186.90	1799.82	1469.60	1174.21

Appendix 4.13 to 4.16 Revaluation of Material Input of Metals Sector Companies

Appendix 4.13

Revaluation of Material Input of Coal India Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**															
1	Explosives	2.09	2.02	1.85	2.84	2.44	5.01	4.09	10.39	8.37	4.31	3.61	2.65	2.18	3.45	2.76
2	Timber	0.53	0.53	0.49	0.57	0.49	0.45	0.37	0.66	0.53	0.56	0.47	0.42	0.35	0.33	0.26
3	P O L/Oil and lubricants	3.75	3.24	2.97	4.51	3.87	3.58	2.92	2.98	2.40	2.02	1.69	2.31	1.90	1.44	1.15
4	HEMM Spares	0.14	0.15	0.14	0.12	0.10	0.08	0.07	0.14	0.11	0.15	0.13	0.18	0.15	0.13	0.10
	Total (A)	6.51	5.94	5.45	8.04	6.91	9.12	7.44	14.17	11.42	7.04	5.89	5.56	4.58	5.35	4.27
(B)	**Stores and Spares Consumed**	3.52	3.74	3.43	3.57	3.07	3.24	2.64	2.70	2.18	3.28	2.75	2.66	2.19	1.58	1.26
	Total Material Input (A+B)	10.03	9.68	8.89	11.61	9.97	12.36	10.09	16.87	13.60	10.32	8.64	8.22	6.77	6.93	5.54

Appendix 4.14

Revaluation of Material Input of Hindalco Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**															
1	Copper Concentrate	13403.78	15245.98	13995.81	14223.65	12218.12	15271.64	12461.66	16155.19	13021.08	13231.19	11074.51	15195.79	12506.14	18104.67	14465.63
2	Alumina	0.00	0.00	0.00	91.62	78.70	388.64	317.13	1255.78	1012.16	2218.61	1856.98	2100.41	1728.64	2957.96	2363.41
3	Bauxite	202.83	188.07	172.65	192.86	165.67	218.84	178.57	234.30	188.85	258.76	216.58	255.39	210.19	322.39	257.59
4	Caustic Soda	316.38	468.08	429.70	587.22	504.42	581.13	474.20	515.85	415.78	497.23	416.18	593.94	488.81	716.10	572.16
5	Calcined Petroleum Coke	333.02	427.70	392.63	432.97	371.92	447.68	365.31	784.81	632.56	928.45	777.11	1020.04	839.49	1398.80	1117.64
6	Rock Phosphate	245.76	338.26	310.52	354.71	304.70	337.95	275.77	417.39	336.42	484.97	405.92	409.12	336.71	277.35	221.60
7	Anode	0.00	0.00	0.00	314.31	269.99	355.44	290.04	380.57	306.74	522.52	437.35	357.44	294.17	446.72	356.93
8	Others	1030.52	1175.01	1078.66	940.16	807.60	1367.20	1115.64	1347.49	1086.08	1078.81	902.96	1086.09	893.85	1183.74	945.81
9	Less: Transfer to Capital Work-in-Progress	-1.35	-0.02	-0.02	-0.99	-0.85	-164.24	-134.02	-35.09	-28.28	-11.09	-9.28	0.00	0.00	0.00	0.00
	Total (A)	15530.94	17843.08	16379.95	17136.51	14720.26	18804.28	15344.29	21056.29	16971.37	19209.45	16078.31	21018.22	17298.00	25407.73	20300.78
(B)	**Stores and Spares Consumed**	382.57	507.99	466.33	587.10	504.32	494.35	403.39	599.58	483.26	684.92	573.28	808.22	665.17	887.19	708.86
(C)	**Purchases of Traded Goods**	522.22	205.98	189.09	0.38	0.33	0.03	0.02	37.04	29.85	1.48	1.24	89.11	73.34	4.92	3.93
	Total Material Input (A+B+C)	16435.73	18557.05	17035.37	17723.99	15224.91	19298.66	15747.71	21692.91	17484.49	19895.85	16652.83	21915.55	18036.50	26299.84	21013.57

Appendix 4.15

Revaluation of Material Input of Tata Steel Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**	6244.01	8014.37	7357.19	9877.40	8484.69	9677.71	7897.01	11678.60	9412.95	9700.01	8118.91	12496.78	10284.85	16877.63	13485.23
(B)	**Stores and Spares Consumed**	1417.26	1693.48	1554.61	2090.89	1796.07	2611.23	2130.76	2305.47	1858.21	2425.11	2029.82	2751.81	2264.74	3306.45	2641.85
(C)	**Purchases of Traded Goods**	180.20	209.52	192.34	453.34	389.42	352.63	287.75	688.32	554.79	991.54	829.92	881.18	725.21	647.21	517.12
	Total Material Input (A+B+C)	7841.47	9917.37	9104.15	12421.63	10670.18	12641.57	10315.52	14672.39	11825.95	13116.66	10978.64	16129.77	13274.80	20831.29	16644.20

Appendix 4.16

Revaluation of Material Input of Vedanta Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**	397.35	572.16	525.24	224.59	192.92	17945.59	14643.60	18849.69	15192.85	17164.00	14366.27	18788.00	15462.52	25209.00	20141.99
(B)	**Stores and Spares Consumed**	244.58	280.03	257.07	159.96	137.41	365.21	298.01	605.65	488.15	542.01	453.66	717.00	590.09	520.00	415.48
(C)	**Purchases of Traded Goods**	536.39	367.01	336.92	105.78	90.87	819.25	668.51	998.46	804.76	1045.24	874.87	580.00	477.34	426.00	340.37
	Total Material Input (A+B+C)	1178.32	1219.20	1119.23	490.33	421.19	19130.05	15610.12	20453.80	16485.76	18751.25	15694.80	20085.00	16529.96	26155.00	20897.85

Appendix 4.17 to 4.20 Revaluation of Material Input of Pharmaceutical Sector Companies

Appendix 4.17

Revaluation of Material Input of Cipla Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**															
1	Purchased Bulk Drugs/ Semi finished goods consumed	1075.24	884.16	811.66	953.33	818.91	1367.62	1115.98	1567.24	1263.20	1409.1	1179.42	1079.06	888.07	1322.84	1056.95
2	Raw Material (Solvents ,Capsules ,etc.)	131.67	139.29	127.87	168.37	144.63	201.84	164.70	942.06	759.30	1190.19	996.19	870.94	716.78	1062.08	848.60
3	Packing Material	558.59	572.55	525.60	663.69	570.11	812.29	662.83	891.11	718.23	956.03	800.20	878.54	723.04	882.64	705.23
4	Intermediates and Others	643.37	796.3	731.00	977.36	839.55	900.9	735.13	127.84	103.04	78.02	65.30	127.5	104.93	35.75	28.56
5	Less Recoverable Duties	-93.83	-91.45	-83.95	-115.92	-99.58	-137.31	-112.04	-101.51	-81.82	0.00	0.00	0.00	0.00	0.00	0.00
	Total (A)	2315.04	2300.85	2112.18	2646.83	2273.63	3145.34	2566.60	3426.74	2761.95	3633.34	3041.11	2956.04	2432.82	3303.31	2639.34
(B)	**Stores and Spares Consumed**	99.73	91.57	84.06	86.43	74.24	84.05	68.58	84.22	67.88	112.28	93.98	94.14	77.48	119.63	95.58
(C)	**Purchases of Traded Goods**	671.13	555.55	509.99	706.89	607.22	773.40	631.09	903.41	728.15	1037.56	868.44	1128.99	929.16	1064.23	850.32
	Total Material Input (A+B+C)	3085.9	2947.97	2706.236	3440.15	2955.089	4002.79	3266.277	4414.37	3557.982	4783.18	4003.522	4179.17	3439.457	4487.17	3585.249

Appendix 4.18

Revaluation of Material Input of Dr. Reddy Laboratories Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**	1065.40	1738.60	1596.03	2277.30	1956.20	2191.80	1788.51	2248.40	1812.21	1988.50	1664.37	1904.60	1567.49	2011.00	1606.79
(B)	**Stores and Spares Consumed**	353.10	76.70	70.41	101.50	87.19	94.60	77.19	375.50	302.65	429.10	359.16	454.40	373.97	508.00	405.89
(C)	**Purchases of Traded Goods**	331.00	307.60	282.38	393.10	337.67	469.00	382.70	526.10	424.04	610.40	510.90	671.50	552.64	671.60	536.61
	Total Material Input (A+B+C)	1749.50	2122.90	1948.82	2771.90	2381.06	2755.40	2248.41	3150.00	2538.90	3028.00	2534.44	3030.50	2494.10	3190.60	2549.29

Appendix 4.19

Revaluation of Material Input of Lupin Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**	1382.42	1592.17	1461.61	1927.21	1655.47	2132.00	1739.71	2239.32	1804.89	2346.74	1964.22	2206.82	1816.21	2259.53	1805.36
(B)	**Stores and Spares Consumed**	154.57	186.00	170.75	221.22	190.03	262.27	214.01	330.06	266.03	407.68	341.23	469.90	386.73	393.26	314.21
(C)	**Purchases of Traded Goods**	384.19	599.27	550.13	776.03	666.61	829.19	676.62	942.50	759.66	1106.73	926.33	1320.21	1086.53	1130.15	902.99
	Total Material Input (A+B+C)	1921.18	2377.44	2182.49	2924.46	2512.11	3223.46	2630.34	3511.88	2830.58	3861.15	3231.78	3996.93	3289.47	3782.94	3022.57

Appendix 4.20

Revaluation of Material Input of Sun Pharmaceutical Industries Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**	718.26	951.71	873.67	705.79	606.27	894.62	730.01	2261.11	1822.45	2019.85	1690.61	2228.45	1834.01	2167.52	1731.85
(B)	**Stores and Spares Consumed**	33.91	118.60	108.87	171.12	146.99	184.93	150.90	345.49	278.46	360.38	301.64	429.33	353.34	470.45	375.89
(C)	**Purchases of Traded Goods**	176.68	187.48	172.11	200.96	172.62	185.04	150.99	934.22	752.98	1170.00	979.29	1236.50	1017.64	1165.99	931.63
	Total Material Input (A+B+C)	928.85	1257.79	1154.65	1077.87	925.89	1264.59	1031.91	3540.82	2853.90	3550.23	2971.54	3894.28	3204.99	3803.96	3039.36

Appendix 4.21 to 4.24 Revaluation of Material Input of Refineries Sector Companies

Appendix 4.21

Revaluation of Material Input of Bharat Petroleum Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

		2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
S.No.	Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**															
1	Raw Material Consumed	62730.40	85562.97	78546.81	97489.49	83743.47	109197.43	89105.10	94424.39	76106.06	61032.44	51084.15	67710.71	55725.91	81467.45	65092.49
2	Packing Material Consumed	139.28	156.26	143.45	158.57	136.21	165.35	134.93	150.36	121.19	168.42	140.97	175.48	144.42	178.50	142.62
	Total (A)	62869.68	85719.23	78690.25	97648.06	83879.68	109362.78	89240.03	94574.75	76227.25	61200.86	51225.12	67886.19	55870.33	81645.95	65235.11
(B)	**Stores and Spares Consumed**	53.25	58.43	53.64	66.64	57.24	65.33	53.31	119.60	96.40	81.76	68.43	11.52	9.48	0.00	0.00
(C)	**Purchases of Traded Goods**	78105.10	112159.15	102962.10	125819.60	108079.04	130897.87	106812.66	117051.71	94343.68	100732.00	84312.68	114220.09	94003.13	125462.73	100244.72
	Total Material Input (A+B+C)	141028.03	197936.81	181705.99	223534.30	192015.96	240325.98	196106.00	211746.06	170667.32	162014.62	135606.24	182117.80	149882.95	207108.68	165479.84

Appendix 4.22

Revaluation of Material Input of Hindustan Petroleum Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

		2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
S.No.	Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**															
1	Raw Material Consumed	40362.01	56943.23	52273.89	63182.61	54273.86	61962.49	50561.39	56158.44	45263.70	40523.83	33918.45	44879.42	36935.76	50937.67	40699.20
2	Packing Material Consumed	143.42	181.67	166.77	183.12	157.30	213.20	173.97	231.40	186.51	287.81	240.90	258.24	212.53	248.63	198.66
	Total (A)	40505.43	57124.90	52440.66	63365.73	54431.16	62175.69	50735.36	56389.84	45450.21	40811.64	34159.34	45137.66	37148.29	51186.30	40897.85
(B)	**Stores and Spares Consumed**	116.66	121.41	111.45	156.39	134.34	167.81	136.93	244.20	196.83	230.64	193.05	296.22	243.79	244.34	195.23
(C)	**Purchases of Traded Goods**	85396.86	109370.73	100402.33	128163.94	110092.82	145137.95	118432.57	129278.36	104198.36	115948.43	97048.84	122731.74	101008.22	142455.74	113822.14
	Total Material Input (A+B+C)	126018.95	166617.04	152954.44	191686.06	164658.33	207481.45	169304.86	185912.40	149845.39	156990.71	131401.22	168165.62	138400.31	193886.38	154915.22

Appendix 4.23

Revaluation of Material Input of Indian Oil Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

		2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
S.No	Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**															
1	Raw Material Consumed	142916.34	202283.10	185695.89	219744.05	188760.14	227012.01	185241.80	205312.29	165481.71	142265.03	119075.83	156950.55	129170.30	188780.12	150835.32
2	Packing Material Consumed	324.91	380.70	349.48	439.38	377.43	457.06	372.96	462.89	373.09	444.22	371.81	429.49	353.47	405.04	323.63
	Total (A)	143241.25	202663.80	186045.37	220183.43	189137.57	227469.07	185614.76	205775.18	165854.80	142709.25	119447.64	157380.04	129523.77	189185.16	151158.94
(B)	**Stores and Spares Consumed**	833.64	897.31	823.73	1052.63	904.21	1199.35	978.67	1509.34	1216.53	1351.21	1130.96	1376.81	1133.11	1495.14	1194.62
(C)	**Purchases of Traded Goods**	155710.85	190824.41	175176.81	188182.20	161648.51	196237.15	160129.51	177533.90	143092.32	143628.80	120217.31	141925.49	116804.68	152117.55	121541.92
	Total Material Input (A+B+C)	299785.74	394385.52	362045.91	409418.26	351690.29	424905.57	346722.95	384818.42	310163.65	287689.26	240795.91	300682.34	247461.57	342797.85	273895.48

Appendix 4.24

Revaluation of Material Input of Reliance Industries Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**	193233.88	274814.00	252279.25	306127.00	262963.09	329313.00	268719.41	255998.00	206334.39	152769.00	127867.65	164250.00	135177.75	198029.00	158225.17
(B)	**Stores and Spares Consumed**	3378.02	3482.00	3196.48	3799.00	3263.34	4446.00	3627.94	4702.00	3789.81	4765.00	3988.31	5035.00	4143.81	5376.00	4295.42
(C)	**Purchases of Traded Goods**	1464.31	1441.00	1322.84	502.00	431.22	524.00	427.58	7134.00	5750.00	4241.00	3549.72	5161.00	4247.50	7268.00	5807.13
	Total Material Input (A+B+C)	198076.21	279737.00	256798.57	310428.00	266657.65	334283.00	272774.93	267834.00	215874.20	161775.00	135405.68	174446.00	143569.06	210673.00	168327.73

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Chapter-5

Labour Productivity

CHAPTER 5

LABOUR PRODUCTIVITY

5.1. Introduction

Labour cost is considered as an important cost in any organisation. Besides from other factors, productivity largely depends on labour. If the labour employed in an organisation utilizes the other factors optimally then it results in a good output with a small investment of input, thus improving productivity.

Labour means human contribution directly or indirectly in production. The role of labour cannot be ignored in spite of increasing use of machines in an organisation. Nobody can deny the fact that the labour force is regarded as one of the most valuable assets for an organisation. All possible efforts should be taken by the management so that the human efforts and material resources can be coordinated in such a manner that the overall organizational goals can be achieved.

Labour can be classified into:

1. Direct Labour

Labour that can be easily identified and attributed to a particular job, product or process is known as direct labour. It includes all labour cost incurred in converting raw material into finished goods. It depends directly in accordance with the volume of output.

2. Indirect Labour

Labour that cannot be easily identified to a particular job, product or process and which is ancillary in the production process is known as indirect labour. According to CIMA, London, "Indirect labour cost means labour cost which cannot be allocated but which can be apportioned to or absorbed by cost centres or cost units." Indirect labour cost includes wages given to supervisory staff, inspectors, watchmen, etc.

"Labour" for the present study includes direct labour only as indirect labour has been covered under the overheads chapter. Labour in the financial statements of the companies under study includes all types of direct labour cost incurred directly attributable on the job, product or process. The term "labour" in this study

includes salary, wages, bonus and benefits, contribution to provident and other funds and employees welfare expenses and others.

This chapter is based on the work published by us in different journals. (Reference No. 9 to 11).

5.2. Departments Dealing with Labour

There are generally five departments in an organisation which deals with labour. The perfect coordination and cooperation of these departments results in the control of labour cost for an organisation.

1. Personnel Department

This department is primarily concerned with the proper selection and training of workers and placing them to jobs for which they are best suited. This department is a service department and it renders only advisory functions.

2. Time Recording Department

The time spend by the worker in the organisation is to be recorded because of the two purposes viz., for time keeping and for time booking. Time keeping is the recording of time for the purpose of attendance and remuneration calculations. Time booking is the recording of time for the purpose of cost analysis and apportionment of labour cost in the business.

3. Pay Roll Department

The main function of this department is to maintain the record of job classification, department and wage rate for each employee, to verify and summaries the time of each worker as shown on the daily time card, to compute the wages and prepare the payroll, deductions and maintain payroll records.

4. Engineering Department

This department helps in maintaining control over working conditions and production methods for each job, department or process.

5. Cost Accounting Department

This department is responsible for analyzing the payroll in order to render routine and special labour cost reports revealing the amount of normal and abnormal idle time, direct and indirect labour, overtime and variances from budged labour costs.

5.3. Labour Control and Improvements Techniques

Labour cost may be excessive due to the following reasons:

- Inefficiency of labour
- Higher wastage of material by labour due to lack of supervision
- High labour turnover
- Idle time and unusual overtime work
- Inclusion of bogus workers in the salary sheet

In order to control the above labour cost following aspects should be considered:

1. Selection, appointment and work allocation among the workers should be proper and appropriate to avoid labour cost.
2. Control on entry and exit of workers should be controlled through attendance register, dial time recorder, time recording clocks, etc.
3. Entries regarding time devoted by labour on the particular job, product, etc.
4. Analysis and payment of remuneration should be properly maintained and proper documentation should be there.
5. Other aspects such as idle time, casual workers, overtime work, labour turnover has to be properly controlled to avoid labour wastage.

Alex (2016) suggested some techniques which are useful to improve the interpersonal skills that may result in increasing labour productivity are as follows:

1. **Be Appreciative**: For improving the productivity of labour, managers and key personnel staff should adopt the rule "Praise in public and blame in private". According to this, an organisation should try to evaluate position things about the employees and appreciate them in public to encourage the employee's confidence.
2. **Personal Attention to Others**: Organisational key personnel should spend some time with their subordinates so that they are able to know the difficulties faced by them in fulfilling their job.
3. **Create Friendly Environment**: Organisation should ensure an environment that provides platform for the people to come together and share their knowledge and skills.

4. **Avoid/ Solve Conflicts**: Organisational managers should try to avoid the conflict, but if it cannot be avoided, they should try to solve them by bringing the parties to the table for negotiation.
5. **Johari Window:** According to this model an organisation can analyse the strengths and weaknesses of an employee from the information gathered from the suggested model to enhance the employee's productivity. as per this Johari Window model, the employee's informations should be divided into the four panel "window" viz., open, hidden, blind and unknown. Open panel has the information about oneself, which is known to the organisation and all. Blind area contains information that a person do not know about himself but which is known to the organisation. Hidden area contains information about the person known by him but the organisation does not know. Unknown area contains the information that is neither known by the person nor the organisation.

5.4. Steps in Measurement of Labour Productivity

Following steps are to be taken for the measurement of labour productivity:

1. Revaluation of Labour Input at Base Year Prices.
2. Computation and Analysis of Labour Productivity Ratios and Labour Productivity Indices.
3. Testing Hypotheses.
4. Computation of Possible Savings.

5.4.1. Revaluation of Labour Input at Base Year Prices

- Revaluation of labour input at base year prices for different companies under the study has been carried out in Appendix 5.1 to 5.24.
- Revalued labour input has been calculated for the period of eight years i.e. from 2010-11 to 2017-18. Labour input in this study includes salary, wages, bonus and benefits, contribution to provident and other funds and employees welfare expenses and others.
- Monetary values of all elements for the years covered by the study of different companies of different sectors have been multiplied with the conversion

factors. The Consumer Price Index for industrial workers has been used for revaluing the labour input.

5.4.2. Computation and Analysis of Labour Productivity Ratios and Labour Productivity Indices

- Labour productivity ratio means output at base year prices per rupee of labour input. For calculating this ratio revalued output (Refer Appendix 3.1 to 3.24) is divided by the revalued input (Refer Appendix 5.1 to 5.24).
- Labour productivity indices have been calculated assuming base year labour productivity ratio as 100.
- Labour productivity index above 100 will indicate the improvement in the productivity as compared to the productivity of the base year while below 100 will mean low productivity as compared to the base year productivity. Labour productivity ratios and indices have been calculated in the table 5.1 to 5.24.

5.4.3. Testing Hypotheses

The present study considers two hypotheses for the purpose of analyzing the labour productivity ratios and indices.

- **For Intra-company Comparison:** First hypothesis has been developed to measure, analyse and compare the labour productivity indices of the sampled company for the study period.

  Null Hypothesis (H_0): There is no significant difference in the labour productivity indices of the sampled company for the study period and can be represented by straight line trend or line of best fit.

  Alternative Hypothesis (H_1): There is a significant difference in the labour productivity indices of the sampled company for the study period and cannot be represented by straight line trend or line of best fit.

  The acceptance of null hypothesis would reveal that the labour productivity indices of the sampled company for the study period are approximately equal. However, rejection of null hypothesis and acceptance of alternative hypothesis would mean that the labour productivity indices of the sampled company differ in the study period indicates that indices cannot be represented by straight line trend. Above hypothesis will be tested with the help of chi-square test at 5% level of significance.

- **For Inter-company Comparison:** Another hypothesis has been developed to study the inter-company relationship i.e. hypothesis developed to measure, analyse and compare the labour productivity ratios of sampled companies.

  Null Hypothesis (H_0): There is no significant difference in the labour productivity ratios of sampled companies.

  Alternative Hypothesis (H_1): There is a significant difference in the labour productivity ratios of sampled companies.

  The acceptance of null hypothesis would reveal that the labour productivity ratios of sample companies are approximately equal. However, rejection of null hypothesis and acceptance of alternative hypothesis would mean that the labour productivity ratios between the sample companies differ. Above inter-company hypothesis will be tested with the help of kruskal wallis one way analysis of variance test.

5.4.4. Computation of Possible Savings

- The possible savings in labour input can be calculated on the basis of following formula:

  Possible Saving in Labour Input = Actual labour input – Standard labour input
- Standard Labour Input = minimum requirement of labour input per ₹ of output X Actual output revalued according to the base year
- Actual labour input means the actual revalued labour input according to base year prices.

5.5. Labour Productivity

Labour productivity of six sectors included in Nifty 50 has been calculated and analysis has been drawn out of it. These six sectors include Automobile, Energy, Information Technology, Metals, Pharmaceutical and Refineries. Below tables shows the salary, wages, bonus and benefits input output ratio, contribution to provident and other funds input output ratio, employees welfare expenses and others input output ratio, total labour input output ratio, labour productivity ratio, labour productivity indices or observed values (O) and expected values (E) and lastly the chi-square test for testing the hypothesis.

5.5.1. Labour Productivity of Automobile Sector Companies

Labour productivity of automobile sector companies has been shown from table 5.1 to 5.4. It shows the labour productivity ratios from 2010-11 to 2017-18 taking 2010-11 as a base year for revaluation of output and input.

Table 5.1

Labour Productivity of Bajaj Auto Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	16892	18399.35	17881.58	17003.01	17842.32	19807.03	18883.71	21190.96
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	389.14	414.05	435.98	465.13	507.47	536.65	563.26	587.97
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0230	0.0225	0.0244	0.0274	0.0284	0.0271	0.0298	0.0277
4	Contribution to Provident and Other Funds (₹ in Crore)	61.45	45.69	57.58	49.31	93.50	47.14	45.11	51.07
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0036	0.0025	0.0032	0.0029	0.0052	0.0024	0.0024	0.0024
6	Employees Welfare Expenses and Others (₹ in Crore)	42.99	38.78	41.69	39.94	42.39	39.83	41.72	38.77
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0025	0.0021	0.0023	0.0023	0.0024	0.0020	0.0022	0.0018
8	Total Labour Input (₹ in Crore)	493.58	498.52	535.25	554.38	643.36	623.62	650.09	677.81
9	Total Labour (Input Output Ratio)	0.0292	0.0271	0.0299	0.0326	0.0361	0.0315	0.0344	0.0320
10	Labour Productivity Ratio	34.2233	36.9079	33.4079	30.6703	27.7330	31.7614	29.0478	31.2639
11	Labour Productivity Indices / Observed Indices (O)	100.00	107.84	97.62	89.62	81.04	92.81	84.88	91.35
12	Computed Value/ Expected Values (E)	101.41	99.05	96.69	94.32	91.96	89.60	87.24	84.88
13	Chi-Square $(O-E)^2/E$	0.0196	0.7812	0.0090	0.2349	1.2985	0.1146	0.0640	0.4939

Average Labour Productivity Indices = 93.14, a = 93.14, b = -1.18, χ^2 = 3.016, S.D. = 8.01, C.V. = 8.60 %

Analysis and Interpretation

Output: The revalued output of Bajaj Auto Ltd. is highlighting a choppy trend. It is the highest ₹ 21190.96 crore in 2017-18 and it is the lowest ₹ 16891.95 crore in 2010-11.

Salary, Wages, Bonus and Benefits: The most important part of labour input is salary, wages, bonus and benefits. It is ₹ 389.14 crore in 2010-11 and reached to ₹ 587.97 crore in 2017-18. Its input output ratio is the highest 0.0298 in 2016-17 while it is the lowest 0.0225 in 2011-12.

Contribution to Provident and Other Funds: Another very important part of total labour input is contribution to provident and other funds. It is the highest ₹ 93.50 crore in 2014-15 while it is the lowest ₹ 45.11 crore in 2016-17. Input output ratio of contribution to provident and other funds is the lowest 0.0024 in 2015-16, 2016-17 and also in 2017-18 as compared to the highest 0.0052 in 2014-15.

Employees Welfare Expenses and Others: It is the highest ₹ 42.99 crore in 2010-11 as compared to the lowest ₹ 38.77 crore in 2017-18. Input output ratio is the lowest 0.0018 in 2017-18 while it is the highest 0.0025 in 2010-11.

Total Labour: Total revalued labour input is ₹ 493.58 crore in 2010-11 and reached to ₹ 677.81 crore in 2017-18. Total labour input output ratio is the highest 0.0361 in 2014-15 while it is the lowest 0.0271 in 2011-12. The lowest labour input output ratio means labour has been best utilized in the year 2016-17. This means that organisation is neither short of labour nor its labour remains idle.

Labour Productivity Ratio: There is a changeable trend in the labour productivity ratios of Bajaj Auto Ltd. It is 34.2233 in 2010-11, 36.9079 in 2011-12, 33.4079 in 2012-13, 30.6703 in 2013-14, 27.7330 in 2014-15, 31.7614 in 2015-16, 29.0478 in 2016-17 and 31.2639 in 2017-18. Labour productivity ratio is the lowest 27.7330 in 2014-15 while it is the highest 36.9079 in 2011-12. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the labour input has not been utilized efficiently. Labour efficiency can also be observed from the average of labour indices which worked out as 93.14 as compared to the base year index of 100. It is concluded from the above that labour efficiency is not there as compared to the base year.

Testing Hypothesis and Interpretation: The standard deviation and coefficient of variation of Bajaj Auto Ltd. is 8.01 and 8.60 % respectively. The computed value of chi-square is 3.016. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence, null hypothesis is accepted and alternative hypothesis is rejected. This highlights that the labour productivity indices of Bajaj Auto Ltd. for the study period are approximately equal and can be represented by straight line trend or line of best fit.

Table 5.2

Labour Productivity of Mahindra & Mahindra Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	23692.18	29120.78	35143.67	33416.69	31931.62	34755.61	37410.97	39883.51
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	1157.16	1224.32	1275.59	1335.00	1350.91	1282.79	1427.67	1470.53
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0488	0.0420	0.0363	0.0400	0.0423	0.0369	0.0382	0.0369
4	Contribution to Provident and Other Funds (₹ in Crore)	134.61	132.04	102.98	136.29	152.76	117.03	127.31	131.69
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0057	0.0045	0.0029	0.0041	0.0048	0.0034	0.0034	0.0033
6	Employees Welfare Expenses and Others (₹ in Crore)	139.75	214.38	183.65	179.63	157.57	190.50	214.83	198.90
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0059	0.0074	0.0052	0.0054	0.0049	0.0055	0.0057	0.0050
8	Total Labour Input (₹ in Crore)	1431.52	1570.74	1562.22	1650.92	1661.24	1590.32	1769.81	1801.12
9	Total Labour (Input Output Ratio)	0.0604	0.0539	0.0445	0.0494	0.0520	0.0458	0.0473	0.0452
10	Labour Productivity Ratio	16.5504	18.5395	22.4960	20.2413	19.2216	21.8545	21.1384	22.1437
11	Labour Productivity Indices / Observed Indices (O)	100.00	112.02	135.92	122.30	116.14	132.05	127.72	133.80
12	Computed Value/ Expected Values (E)	110.11	113.65	117.18	120.72	124.26	127.80	131.34	134.88
13	Chi-Square $(O-E)^2/E$	0.9276	0.0233	2.9967	0.0206	0.5311	0.1410	0.0998	0.0087

Average Labour Productivity Indices = 122.49, a =122.49, b = 1.77, χ^2 = 4.749, S.D. = 11.63, C.V. = 9.50 %

Analysis and Interpretation

Output: The revalued output of Mahindra & Mahindra Ltd. is ₹ 23692.18 crore in 2010-11, ₹ 29120.78 crore in 2011-12, ₹ 35143.67 crore in 2012-13, ₹ 33416.69 crore in 2013-14, ₹ 31931.62 crore in 2014-15, ₹ 34755.61 crore in 2015-16, ₹ 37410.97 crore in 2016-17, ₹ 39883.51 crore in 2017-18.

Salary, Wages, Bonus and Benefits: It is presenting an increasing trend except in 2015-16. It is the highest ₹ 1470.53 crore in 2017-18 and the lowest ₹ 1157.16 crore in 2010-11. Salary, wages, bonus and benefits input output ratio is the highest 0.0488 in 2010-11 while it is the lowest 0.0363 in 2012-13.

Contribution to Provident and Other Funds: It is the highest ₹ 152.76 crore in 2014-15 while it is the lowest ₹ 102.98 crore in 2012-13. Input output ratio of contribution to provident and other funds is the lowest 0.0029 in 2012-13 as compared to the highest 0.0057 in 2010-11.

Employees Welfare Expenses and Others: It is the lowest ₹ 139.75 crore in 2010-11 as compared to ₹ 214.83 crore in 2016-17. Input output ratio is 0.0059 in 2010-11, 0.0074 in 2011-12, 0.0052 in 2012-13, 0.0054 in 2013-14, 0.0049 in 2014-15, 0.0055 in 2015-16, 0.0057 in 2016-17 and 0.0050 in 2017-18. It is the lowest 0.0049 in 2014-15 indicates fewer amounts have been expended on employee welfare expenses and others.

Total Labour: Total labour input is ₹ 1431.52 crore in 2010-11, then it is increased to ₹ 1570.74 crore in 2011-12, then it slightly decreased to ₹ 1562.22 crore in 2012-13, then it increased to ₹ 1650.92 crore in 2013-14, ₹ 1661.24 crore in 2014-15, decreased to ₹ 1590.32 crore in 2015-16, ₹ 1769.81 crore in 2016-17 and ₹ 1801.12 crore in 2017-18. Total labour input output ratio is the highest 0.0604 in 2010-11 while it is the lowest 0.0445 in 2012-13.

Labour Productivity Ratio: Labour productivity ratio is 16.5504 in 2010-11, 18.5395 in 2011-12, 22.4960 in 2012-13, 20.2413 in 2013-14, 19.2216 in 2014-15, 21.8545 in 2015-16, 21.1384 in 2016-17 and 22.1437 in 2017-18. Labour productivity ratio is the lowest 16.5504 in 2010-11 while it is the highest 22.4960 in 2012-13. The highest ratio exhibits efficiency and effectiveness while the lowest ratio exhibits that the labour input has not been utilized efficiently. Labour efficiency can also be observed from the average of labour indices which worked

out as 122.49 as compared to the base year index of 100. This indicates that labour has been utilized efficiently as compared to the base year.

Testing Hypothesis and Interpretation: The standard deviation worked out is 11.63 with 9.50 % of variability. The computed value of chi-square of Mahindra & Mahindra Ltd. is 4.749. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the labour productivity indices of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 5.3

Labour Productivity of Maruti Suzuki India Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	37071.20	33307.52	38159.96	36346.27	40579.12	48726.04	57572.80	65397.27
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	625.60	702.03	766.02	922.77	1012.91	1180.98	1354.33	1581.26
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0169	0.0211	0.0201	0.0254	0.0250	0.0242	0.0235	0.0242
4	Contribution to Provident and Other Funds (₹ in Crore)	30.30	30.46	56.00	52.57	65.32	66.75	62.07	83.12
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0008	0.0009	0.0015	0.0014	0.0016	0.0014	0.0011	0.0013
6	Employees Welfare Expenses and Others (₹ in Crore)	47.70	46.33	73.24	68.52	73.71	102.60	103.41	132.25
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0013	0.0014	0.0019	0.0019	0.0018	0.0021	0.0018	0.0020
8	Total Labour Input (₹ in Crore)	703.60	778.83	895.26	1043.86	1151.93	1350.33	1519.81	1796.63
9	Total Labour (Input Output Ratio)	0.0190	0.0234	0.0235	0.0287	0.0284	0.0277	0.0264	0.0275
10	Labour Productivity Ratio	52.6879	42.7662	42.6247	34.8191	35.2270	36.0846	37.8815	36.4000
11	Labour Productivity Indices / Observed Indices (O)	100.00	81.17	80.90	66.09	66.86	68.49	71.90	69.09
12	Computed Value/ Expected Values (E)	88.03	84.47	80.90	77.34	73.78	70.22	66.66	63.09
13	Chi-Square $(O-E)^2/E$	1.6282	0.1287	0.0000	1.6382	0.6490	0.0426	0.4123	0.5692

Average Labour Productivity Indices = 75.56, a = 75.56, b= -1.78, χ^2 = 5.068, S.D. = 10.77, C.V. = 14.25 %

Analysis and Interpretation

Output: The output of Maruti Suzuki India Ltd. is depicting an erratic trend. It is the highest ₹ 65397.27 crore in 2017-18 and it is the lowest ₹ 33307.52 crore in 2011-12.

Salary, Wages, Bonus and Benefits: The important part to analyse in labour input is salary, wages, bonus and benefits. It is showing an upward trend with ₹ 625.60 crore in 2010-11 and reached to ₹ 1581.26 crore on 2017-18. It is the highest ₹ 1581.26 crore in 2017-18 while it is the lowest ₹ 625.60 in 2010-11. Salary, wages, bonus and benefits input output ratio is the highest 0.0254 in 2013-14 while it is the lowest 0.0169 in 2010-11.

Contribution to Provident and Other Funds: Another important aspect is contribution to provident and other funds. It is the highest ₹ 83.12 crore in 2017-18 while it is the lowest ₹ 30.30 crore in 2010-11. Input output ratio of contribution to provident and other funds is the lowest 0.0008 in 2010-11 as compared to the highest 0.0016 in 2014-15.

Employees Welfare Expenses and Others: It is the highest ₹ 132.25 crore in 2017-18 while it is the lowest ₹ 46.33 crore in 2011-12. Input output ratio is the lowest 0.0013 in 2010-11 and it is the highest 0.0021 in 2015-16.

Total Labour: Total labour input of Maruti Suzuki India Ltd. is showing an increasing trend this means that expenses on labour input has increased on year to year basis. It is the lowest ₹ 703.60 crore in 2010-11 as compared to ₹ 1796.63 crore in 2017-18. Total labour input output ratio is the highest 0.0287 in 2013-14 while it is the lowest 0.0190 in 2010-11. The lowest labour input output ratio means labour is best utilized in the year 2010-11.

Labour Productivity Ratio: It is the lowest 34.8191 in 2013-14 while it is the highest 52.6879 in 2010-11. The highest ratio portrays efficiency and effectiveness while the lowest ratio conveys that the labour input has not been utilized efficiently. Improvement in labour efficiency can also be observed from the average of labour indices which is 75.56 which is much lower than the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation and coefficient of variation of Maruti Suzuki India Ltd. is 10.77 and 14.25 % respectively. The computed value of chi-square is 5.068. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the labour productivity ratios of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 5.4

Labour Productivity of Tata Motors Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	47157.19	49807.74	40124.16	31410.17	30067.20	37267.99	37072.17	48923.62
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	1841.62	2024.88	1935.27	1797.32	1810.02	1730.70	2072.74	2099.54
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0391	0.0407	0.0482	0.0572	0.0602	0.0464	0.0559	0.0429
4	Contribution to Provident and Other Funds (₹ in Crore)	219.49	194.34	173.70	167.05	161.88	116.89	136.34	149.73
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0047	0.0039	0.0043	0.0053	0.0054	0.0031	0.0037	0.0031
6	Employees Welfare Expenses and Others (₹ in Crore)	232.91	264.99	265.60	231.31	244.68	207.58	245.28	265.65
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0049	0.0053	0.0066	0.0074	0.0081	0.0056	0.0066	0.0054
8	Total Labour Input (₹ in Crore)	2294.02	2484.21	2374.57	2195.68	2216.58	2055.16	2454.36	2514.91
9	Total Labour (Input Output Ratio)	0.0486	0.0499	0.0592	0.0699	0.0737	0.0551	0.0662	0.0514
10	Labour Productivity Ratio	20.5566	20.0497	16.8974	14.3055	13.5647	18.1338	15.1046	19.4535
11	Labour Productivity Indices / Observed Indices (O)	100.00	97.53	82.20	69.59	65.99	88.21	73.48	94.63
12	Computed Value/ Expected Values (E)	89.93	88.22	86.52	84.81	83.10	81.39	79.69	77.98
13	Chi-Square $(O-E)^2/E$	1.1276	0.9828	0.2153	2.7306	3.5245	0.5715	0.4837	3.5568

Average Labour Productivity Indices =83.95, a = 83.95, b = -0.85, χ^2 = 13.193, S.D. = 12.33, C.V. = 14.69%

Analysis and Interpretation

Output: The revalued output of Tata Motors Ltd. the highest ₹ 49807.74 crore in 2011-12 while it is the lowest ₹ 30067.20 crore in 2014-15.

Salary, Wages, Bonus and Benefits: It is the highest ₹ 2099.54 crore in 2017-18 and the lowest ₹ 1730.70 crore in 2015-16. Salary, wages, bonus and benefits input output ratio is 0.0391 in 2010-11, 0.0407 in 2011-12, 0.0482 in 2012-13, 0.0572 in 2013-14, 0.0602 in 2014-15, 0.0464 in 2015-16, 0.0559 in 2016-17 and 0.0429 in 2017-18. It is the highest 0.0602 in 2014-15 while it is the lowest 0.0391 in 2010-11.

Contribution to Provident and Other Funds: It is the highest ₹ 219.49 crore in 2010-11 while it is the lowest ₹ 116.89 crore in 2015-16. Input output ratio of contribution to provident and other funds is the lowest 0.0031 in 2015-16 and 2017-18 as compared to the highest 0.0054 in 2014-15.

Employees Welfare Expenses and Others: It is the lowest ₹ 207.58 crore in 2015-16 as compared to ₹ 265.65 crore in 2017-18 which is the highest. Input output ratio is the lowest 0.0049 in 2010-11 and the highest 0.0081 in 2014-15.

Total Labour: Total labour input expense is ₹ 2294.02 crore in 2010-11, then it is increased to ₹ 2484.21 crore in 2011-12, then it decreased to ₹ 2374.57 crore in 2012-13, then again it decreased to ₹ 2195.68 crore in 2013-14, then it slightly increased to ₹ 2216.58 crore in 2014-15, decreased to ₹ 2055.16 crore in 2015-16, then it increased to ₹ 2454.36 crore in 2016-17 and lastly it reached to ₹ 2514.91 crore in 2017-18. Total labour input output ratio is the highest 0.0737 in 2014-15

while it is the lowest 0.0486 in 2010-11. The lowest labour input output ratio means total labour is best utilized in the year 2010-11 as compared to other years under study of Tata Motors Ltd.

Labour Productivity Ratio: Labour productivity ratio is the lowest 13.5647 in 2014-15 while it is the highest 20.5566 in 2010-11. The highest ratio demonstrates efficiency and effectiveness while the lowest ratio depicts that the labour input has not been utilized efficiently. Labour efficiency can also be analysed from the average of labour indices. It is 83.95 which is less than the base year index of 100. This manifests that on an average labour is not utilized efficiently.

Testing Hypothesis and Interpretation: The standard deviation of Tata Motors Ltd. calculated is 12.33 and its coefficient of variation is 14.69% indicates approx. 15% of variability. The calculated value of chi-square is 13.193 while the table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This depicts that the labour productivity indices of the Tata Motors Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

5.5.2 Labour Productivity of Energy Sector Companies

Labour productivity of energy sector companies has been displayed from table 5.5 to 5.8 from 2010-11 to 2017-18 taking 2010-11 as a base year for revaluation.

Table 5.5

Labour Productivity of GAIL (India) Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	32844.73	37024.85	41429.76	47148.15	46615.02	44514.51	40629.38	43636.95
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	546.39	372.44	445.92	457.97	450.00	481.21	493.78	625.84
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0166	0.0101	0.0108	0.0097	0.0097	0.0108	0.0122	0.0143
4	Contribution to Provident and Other Funds (₹ in Crore)	60.27	77.08	110.14	87.62	94.23	101.37	220.18	76.87
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0018	0.0021	0.0027	0.0019	0.0020	0.0023	0.0054	0.0018
6	Employees Welfare Expenses and Others (₹ in Crore)	114.57	111.18	101.36	101.23	105.66	93.74	105.95	122.41
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0035	0.0030	0.0024	0.0021	0.0023	0.0021	0.0026	0.0028
8	Total Labour Input (₹ in Crore)	721.23	560.70	657.42	646.82	649.89	676.32	819.91	825.13
9	Total Labour (Input Output Ratio)	0.0220	0.0151	0.0159	0.0137	0.0139	0.0152	0.0202	0.0189
10	Labour Productivity Ratio	45.5399	66.0328	63.0185	72.8924	71.7277	65.8182	49.5535	52.8852
11	Labour Productivity Indices / Observed Indices (O)	100.00	145.00	138.38	160.06	157.51	144.53	108.81	116.13
12	Computed Value/ Expected Values (E)	135.98	135.35	134.73	134.11	133.49	132.87	132.25	131.63
13	Chi-Square $(O-E)^2/E$	9.5180	0.6874	0.0987	5.0211	4.3195	1.0227	4.1536	1.8253

Average Labour Productivity Indices =133.80, a = 133.80, b= - 0.31, χ^2=26.646, S.D. = 21.19, C.V. = 15.84%

Analysis and Interpretation

Output: The revalued output of GAIL (India) Ltd. is the highest ₹ 47148.15 crore in 2013-14 and it is the lowest ₹ 32844.73 crore in 2010-11.

Salary, Wages, Bonus and Benefits: The most important chunk of labour input is salary, wages, bonus and benefits. It is the highest ₹ 625.84 crore in 2017-18 as compared to the lowest ₹ 372.44 crore in 2011-12. Its input output ratio is very important to calculate as this represents for one ₹ of output how much input is required. Its input output ratio is the highest 0.0166 in 2010-11 while it is the lowest 0.0097 in 2013-14 and 2014-15.

Contribution to Provident and Other Funds: Contribution to provident and other funds is the highest ₹ 220.18 crore in 2016-17 while it is the lowest ₹ 60.27 crore in 2010-11. Input output ratio of contribution to provident and other funds is the lowest 0.0018 in 2010-11 and also in 2017-18 as compared to the highest 0.0054 in 2016-17.

Employees Welfare Expenses and Others: It is ₹ 114.57 crore in 2010-11, ₹ 111.18 crore in 2011-12, ₹ 101.36 crore in 2012-13, ₹ 101.23 crore in 2013-14, ₹ 105.66 crore in 2014-15, ₹ 93.74 crore in 2015-16, ₹ 105.95 crore in 2016-17 and ₹ 122.41 crore in 2017-18. Its input output ratio is the lowest 0.0021 in 2013-14 and 2015-16 while it is the highest 0.0035 in 2010-11.

Total Labour: Total labour input is ₹ 721.23 crore in 2010-11, decreased to ₹ 560.70 crore in 2011-12 then it slightly increased and reached to ₹ 657.42 crore in 2012-13, it reached to ₹ 646.82 crore in 2013-14, ₹ 649.89 crore in 2014-15 then it increased and reached to ₹ 676.32 crore in 2015-16, ₹ 819.91 crore in 2016-17 and lastly it increased and ultimately reached to ₹ 825.13 crore in 2017-18. Total labour input output ratio is the highest 0.0220 in 2010-11 while it is the lowest 0.0137 in 2013-14. The lowest labour input output ratio means labour has been best utilized in the year 2013-14. This means that organisation is neither short of labour nor its labour remains idle.

Labour Productivity Ratio: Labour productivity ratio is 45.5399 in 2010-11, 66.0328 in 2011-12, 63.0185 in 2012-13, 72.8924 in 2013-14, 71.7277 in 2014-15, 65.8182 in 2015-16, 49.5535 in 2016-17 and 52.8852 in 2017-18. Labour productivity ratio is the lowest 45.5399 in 2010-11 while it is the highest 72.8924

in 2013-14. The highest ratio manifests efficiency and effectiveness while the lowest ratio indicates that the labour input has not been utilized efficiently as compared to the other years but in this case it is greater than one depicts more output from less input. Labour efficiency can also be analysed from the average of labour indices which worked out to 133.80 as compared to the base year index of 100 of 2010-11. It is concluded from the above that labour efficiency is there as compared to the base year labour.

Testing Hypothesis and Interpretation: The standard deviation and coefficient of variation of GAIL (India) Ltd. is 21.19 and 15.84 % respectively. The computed value of chi-square is 26.646. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is more as compared to the table value hence, null hypothesis is rejected and alternative hypothesis is accepted. This portrays that the labour productivity indices of GAIL (India) Ltd. for the study period are not equal and cannot be represented by straight line trend or line of best fit.

Table 5.6

Labour Productivity of NTPC Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	57407.30	59514.54	59078.16	60961.58	60721.91	60009.61	65298.71	68081.15
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	2158.44	2307.06	2203.58	1849.63	1808.82	1711.73	1829.21	2252.13
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0376	0.0388	0.0373	0.0303	0.0298	0.0285	0.0280	0.0331
4	Contribution to Provident and Other Funds (₹ in Crore)	337.83	273.08	311.71	762.51	373.16	369.09	702.74	395.25
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0059	0.0046	0.0053	0.0125	0.0061	0.0062	0.0108	0.0058
6	Employees Welfare Expenses and Others (₹ in Crore)	293.44	272.38	297.14	339.13	414.07	369.91	287.69	354.40
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0051	0.0046	0.0050	0.0056	0.0068	0.0062	0.0044	0.0052
8	Total Labour Input (₹ in Crore)	2789.71	2852.51	2812.42	2951.28	2596.05	2450.73	2819.64	3001.78
9	Total Labour (Input Output Ratio)	0.0486	0.0479	0.0476	0.0484	0.0428	0.0408	0.0432	0.0441
10	Labour Productivity Ratio	20.5782	20.8639	21.0062	20.6560	23.3901	24.4864	23.1585	22.6803
11	Labour Productivity Indices / Observed Indices (O)	100.00	101.39	102.08	100.38	113.66	118.99	112.54	110.21
12	Computed Value/ Expected Values (E)	99.44	101.71	103.99	106.27	108.55	110.82	113.10	115.38
13	Chi-Square $(O-E)^2/E$	0.0032	0.0010	0.0351	0.3265	0.2414	0.6022	0.0028	0.2310

Average Labour Productivity Indices = 107.41, a = 107.41, b = 1.14, χ^2 = 1.443, S.D. = 6.86, C.V. = 6.39 %

Analysis and Interpretation

Output: The revalued output of NTPC Ltd. is ₹ 57407.30 crore in 2010-11 and reached to ₹ 68081.15 crore in 2017-18.

Salary, Wages, Bonus and Benefits: It is depicting a choppy trend. It is the highest ₹ 2307.06 crore in 2011-12 and the lowest ₹ 1711.73 crore in 2015-16.

Salary, wages, bonus and benefits input output ratio is the highest 0.0388 in 2011-12 while it is the lowest 0.0280 in 2016-17.

Contribution to Provident and Other Funds: It is the highest ₹ 762.51 crore in 2013-14 while it is the lowest ₹ 273.08 crore in 2011-12. Input output ratio of contribution to provident and other funds is the lowest 0.0046 in 2011-12 as compared to the highest 0.0125 in 2013-14.

Employees Welfare Expenses and Others: It is the lowest ₹ 272.38 crore in 2011-12 as compared to the highest ₹ 414.07 crore in 2014-15. Input output ratio is 0.0051 in 2010-11, 0.0046 in 2011-12, 0.0050 in 2012-13, 0.0056 in 2013-14, 0.0068 in 2014-15, 0.0062 in 2015-16, 0.0044 in 2016-17 and 0.0052 in 2017-18. It is the lowest 0.0044 in 2016-17.

Total Labour: Total labour input is ₹ 2789.71 crore in 2010-11, ₹ 2852.51 crore in 2011-12, ₹ 2812.42 crore in 2012-13, ₹ 2951.28 crore in 2013-14, ₹ 2596.05 crore in 2014-15, ₹ 2450.73 crore in 2015-16, ₹ 2819.64 crore in 2016-17 and ₹ 3001.78 crore in 2017-18. Total labour input output ratio is the highest 0.0486 in 2010-11 while it is the lowest 0.0408 in 2015-16.

Labour Productivity Ratio: Labour productivity ratio is 20.5782 in 2010-11 and reached to 22.6803 in 2017-18. Labour productivity ratio is the lowest 20.5782 in 2010-11 while it is the highest 24.4864 in 2015-16. The highest ratio presents efficiency and effectiveness while the lowest ratio indicates that the labour input has not been utilized efficiently as compared to other years. Labour efficiency can also be observed from the average of labour indices which worked out as 107.41.

Testing Hypothesis and Interpretation: The standard deviation is 6.86 with coefficient of variation 6.39% indicated the variability. The computed value of chi-square is 1.443. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the labour productivity indices of the NTPC Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 5.7

Labour Productivity of Oil and Natural Gas Corporation Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	71732.86	74244.84	75951.96	74017.52	70984.50	70792.55	70326.36	74166.87
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	5020.13	4767.55	5705.84	4901.62	4894.31	4385.41	4851.06	5841.37
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0700	0.0642	0.0751	0.0662	0.0689	0.0619	0.0690	0.0788
4	Contribution to Provident and Other Funds (₹ in Crore)	328.37	696.38	373.30	688.72	677.35	671.60	660.01	722.54
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0046	0.0094	0.0049	0.0093	0.0095	0.0095	0.0094	0.0097
6	Employees Welfare Expenses and Others (₹ in Crore)	1379.71	808.82	2567.20	2348.70	615.97	878.33	2020.03	651.67
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0192	0.0109	0.0338	0.0317	0.0087	0.0124	0.0287	0.0088
8	Total Labour Input (₹ in Crore)	6728.21	6272.75	8646.34	7939.05	6187.63	5935.34	7531.10	7215.59
9	Total Labour (Input Output Ratio)	0.0938	0.0845	0.1138	0.1073	0.0872	0.0838	0.1071	0.0973
10	Labour Productivity Ratio	10.6615	11.8361	8.7843	9.3232	11.4720	11.9273	9.3381	10.2787
11	Labour Productivity Indices / Observed Indices (O)	100.00	111.02	82.39	87.45	107.60	111.87	87.59	96.41
12	Computed Value/ Expected Values (E)	99.44	99.04	98.64	98.24	97.84	97.44	97.04	96.64
13	Chi-Square $(O-E)^2/E$	0.0031	1.4474	2.6770	1.1860	0.9739	2.1378	0.9205	0.0005

Average Labour Productivity Indices = 98.04, a = 98.04, b = - 0.20, χ^2 = 9.346, S.D. = 10.75, C.V. = 10.96 %

Analysis and Interpretation

Output: The output of Oil and Natural Gas Corporation Ltd. is having a inconstant trend. It is the highest ₹ 75951.96 crore in 2012-13 and it is the lowest ₹ 70326.36 crore in 2016-17.

Salary, Wages, Bonus and Benefits: The important segment to analyse in labour input is salary, wages, bonus and benefits. It is showing the inconsistent trend with ₹ 5020.13 crore in 2010-11, ₹ 4767.55 crore in 2011-12, ₹ 5705.84 crore in 2012-13, ₹ 4901.62 crore in 2013-14, ₹ 4894.31 crore in 2014-15, ₹ 4385.41 crore in 2015-16, ₹ 4851.06 crore in 2016-17 and ₹ 5841.37 crore in 2017-18. Its input output ratio is the highest 0.0788 in 2017-18 while it is the lowest 0.0619 in 2015-16.

Contribution to Provident and Other Funds: It is the highest ₹ 722.54 crore in 2017-18 while it is the lowest ₹ 328.37 crore in 2010-11. Input output ratio of contribution to provident and other funds is the lowest 0.0046 in 2010-11 as compared to the highest 0.0097 in 2017-18.

Employees Welfare Expenses and Others: It is the highest ₹ 2567.20 crore in 2012-13 while it is the lowest ₹ 615.97 crore in 2014-15. Input output ratio is the lowest 0.0087 in 2014-15 and it is the highest 0.0338 in 2012-13.

Total Labour: Total labour input of Oil and Natural Gas Corporation Ltd. is the lowest ₹ 5935.34 crore in 2015-16 as compared to the highest ₹ 8646.34 crore in

2012-13. Total labour input output ratio is the highest 0.1138 in 2012-13 while it is the lowest 0.0838 in 2015-16. The lowest labour input output ratio means labour is best utilized in the year 2015-16.

Labour Productivity Ratio: Labour productivity ratio of Oil and Natural Gas Corporation Ltd. is 10.6615 in 2010-11, 11.8361 in 2011-12, 8.7843 in 2012-13, 9.3232 in 2013-14, 11.4720 in 2014-15, 11.9273 in 2015-16, 9.3381 in 2016-17 and 10.2787 in 2017-18. It is the lowest 8.7843 in 2012-13 while it is the highest 11.9273 in 2015-16. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the labour input has not been utilized efficiently. Improvement in labour efficiency can also be observed from the average of labour indices which is 98.04 which is lower than the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation and coefficient of variation of Oil and Natural Gas Corporation Ltd. is 10.75 and 10.96 % respectively. The computed value of chi-square is 9.346. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the labour productivity ratios of the company for the study period of eight years are approximately same and can be represented by straight line trend or line of best fit.

Table 5.8

Labour Productivity of Power Grid Corporation of India Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	9098.75	9900.64	11449.39	12828.67	14330.71	17812.35	21872.62	24582.29
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	510.66	615.62	539.62	507.85	437.20	443.04	559.83	824.55
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0561	0.0622	0.0471	0.0396	0.0305	0.0249	0.0256	0.0335
4	Contribution to Provident and Other Funds (₹ in Crore)	149.22	81.60	117.50	121.64	192.39	123.18	232.78	71.16
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0164	0.0082	0.0103	0.0095	0.0134	0.0069	0.0106	0.0029
6	Employees Welfare Expenses and Others (₹ in Crore)	86.01	80.84	84.80	89.01	104.37	99.56	105.28	122.43
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0095	0.0082	0.0074	0.0069	0.0073	0.0056	0.0048	0.0050
8	Total Labour Input (₹ in Crore)	745.89	778.06	741.92	718.50	733.96	665.79	897.89	1018.13
9	Total Labour (Input Output Ratio)	0.0820	0.0786	0.0648	0.0560	0.0512	0.0374	0.0411	0.0414
10	Labour Productivity Ratio	12.1985	12.7248	15.4322	17.8547	19.5253	26.7538	24.3601	24.1444
11	Labour Productivity Indices / Observed Indices (O)	100.00	104.31	126.51	146.37	160.06	219.32	199.70	197.93
12	Computed Value/ Expected Values (E)	96.17	113.48	130.80	148.12	165.43	182.75	200.07	217.38
13	Chi-Square $(O-E)^2/E$	0.1526	0.7411	0.1409	0.0206	0.1743	7.3186	0.0007	1.7406

Average Labour Productivity Indices= 156.78, a= 156.78, b = 8.66, χ^2= 10.289, S.D.= 42.51, C.V. = 27.12%

Analysis and Interpretation

Output: The output of Power Grid Corporation of India Ltd. is reflecting an increasing trend with the lowest ₹ 9098.75 crore in 2010-11 while the highest ₹ 24582.29 crore in 2017-18.

Salary, Wages, Bonus and Benefits: It is depicting a changing trend. It is the maximum ₹ 824.55 crore in 2017-18 as compared to the minimum ₹ 437.20 crore in 2014-15. Its input output ratio is the maximum 0.0622 in 2011-12 while it is the minimum 0.0249 in 2015-16.

Contribution to Provident and Other Funds: It is the highest ₹ 232.78 crore in 2016-17 while it is the lowest ₹ 71.16 crore in 2017-18. Input output ratio of contribution to provident and other funds is the lowest 0.0029 in 2017-18 as compared to the highest 0.0164 in 2010-11.

Employees Welfare Expenses and Others: It is the highest ₹ 122.43 crore in 2017-18 while it is the lowest ₹ 80.84 crore in 2011-12. Input output ratio is the lowest 0.0048 in 2016-17 and it is the highest 0.0095 in 2010-11.

Total Labour: Total labour input of Power Grid Corporation of India Ltd. is the lowest ₹ 665.79 crore in 2015-16 as compared to the highest ₹ 1018.13 crore in 2017-18. Total labour input output ratio is the highest 0.0820 in 2010-11 while it is the lowest 0.0374 in 2015-16. The lowest labour input output ratio means labour is best utilized in the year 2015-16.

Labour Productivity Ratio: Labour productivity ratio of Power Grid Corporation of India Ltd. is 12.1985 in 2010-11 and after facing many fluctuations during the study period reached to 24.1444 in 2017-18. It is the lowest 12.1985 in 2010-11 while it is the highest 26.7538 in 2015-16. The highest ratio demonstrates efficiency and effectiveness. Improvement in labour efficiency can also be observed from the average of labour indices which is 156.78 which is lower than the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation and coefficient of variation of Power Grid Corporation of India Ltd. is 42.51 and 27.12 % respectively. The computed value of chi-square is 10.289. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null

hypothesis is accepted and alternative hypothesis is rejected. This highlights that the labour productivity ratios of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

5.5.3. Labour Productivity of Information Technology Sector Companies

Labour productivity of information technology sector companies has been displayed in table 5.9 to 5.12

Table 5.9

Labour Productivity of Infosys Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	26532.00	30814.51	33555.12	38284.27	40813.42	47702.30	51314.87	52702.04
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	11994.00	13862.54	16340.75	18199.08	17572.95	18707.13	19632.37	20045.81
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.4521	0.4499	0.4870	0.4754	0.4306	0.3922	0.3826	0.3804
4	Contribution to Provident and Other Funds (₹ in Crore)	410.00	373.82	316.39	329.62	372.12	371.41	417.28	440.63
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0155	0.0121	0.0094	0.0086	0.0091	0.0078	0.0081	0.0084
6	Employees Welfare Expenses and Others (₹ in Crore)	55.00	45.23	25.95	50.36	62.38	73.33	125.84	100.81
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0021	0.0015	0.0008	0.0013	0.0015	0.0015	0.0025	0.0019
8	Total Labour Input (₹ in Crore)	12459.00	14281.58	16683.08	18579.05	18007.46	19151.87	20175.49	20587.25
9	Total Labour (Input Output Ratio)	0.4696	0.4635	0.4972	0.4853	0.4412	0.4015	0.3932	0.3906
10	Labour Productivity Ratio	2.1295	2.1576	2.0113	2.0606	2.2665	2.4907	2.5434	2.5599
11	Labour Productivity Indices / Observed Indices (O)	100.00	101.32	94.45	96.76	106.43	116.96	119.44	120.21
12	Computed Value/ Expected Values (E)	94.06	97.74	101.42	105.11	108.79	112.47	116.15	119.83
13	Chi-Square $(O-E)^2/E$	0.3751	0.1309	0.4797	0.6621	0.0511	0.1795	0.0929	0.0012

Average Labour Productivity Indices = 106.95, a = 106.95, b = 1.84, χ^2 = 1.972, S.D. = 9.83, C.V. = 9.19 %.

Analysis and Interpretation

Output: The revalued output of Infosys Ltd. has an increasing trend. It is the lowest ₹ 26532.00 crore in 2010-11 and the highest ₹ 52702.04 crore in 2017-18.

Salary, Wages, Bonus and Benefits: It is ₹ 11994.00 crore in 2010-11 and reached to ₹ 20045.81 crore in 2017-18. Its input output ratio is the highest 0.4870 in 2012-13 while it is the lowest 0.3804 in 2017-18.

Contribution to Provident and Other Funds: Another essential share of the total labour input is contribution to provident and other funds. It is the lowest ₹ 316.39 crore in 2012-13 as compared to the highest ₹ 440.63 crore in 2017-18. Its input output ratio is the lowest 0.0078 in 2015-16 as compared to the highest 0.0155 in 2010-11.

Employees Welfare Expenses and Others: It is the minimum ₹ 25.95 crore in 2012-13 while the maximum ₹ 125.84 crore in 2016-17. Its input output ratio is the lowest 0.0008 in 2012-13 while it is the highest 0.0025 in 2016-17.

Total Labour: Total labour input lies between ₹ 12459.00 crore in 2010-11 and ₹ 20587.25 crore in 2017-18. The lowest labour input output ratio is in the year 2017-18 with 0.3906. This means labour is the best utilized in the year 2017-18.

Labour Productivity Ratio: Labour productivity ratio is the lowest 2.0113 in 2012-13 while it is the highest 2.5599 in 2017-18. The higher ratio depicts efficiency and effectiveness while the lowest ratio indicates that the labour input has not been utilized efficiently. Improvement in labour efficiency can also be observed from the average of labour indices which worked out to 106.95 as compared to the base year index of 100 which is slightly higher than the base year.

Testing Hypothesis and Interpretation: The standard deviation of Infosys Ltd. is 9.83 with 9.19 % of variability. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square is 1.972. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This demonstrate that the labour productivity indices of Infosys Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 5.10

Labour Productivity of Tata Consultancy Services Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	29771.01	38137.37	43513.96	55314.66	62904.22	74998.91	80044.98	82424.84
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	8884.06	11482.22	12611.18	14526.97	17524.81	18044.24	28607.15	29800.54
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.2984	0.3011	0.2898	0.2626	0.2786	0.2406	0.3574	0.3615
4	Contribution to Provident and Other Funds (₹ in Crore)	596.02	705.84	812.16	888.04	1102.60	1269.87	1945.57	2006.61
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0200	0.0185	0.0187	0.0161	0.0175	0.0169	0.0243	0.0243
6	Employees Welfare Expenses and Others (₹ in Crore)	710.23	826.62	874.06	963.97	995.68	1102.19	818.91	843.22
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0239	0.0217	0.0201	0.0174	0.0158	0.0147	0.0102	0.0102
8	Total Labour Input (₹ in Crore)	10190.31	13014.68	14297.40	16378.99	19623.09	20416.30	31371.63	32650.37
9	Total Labour (Input Output Ratio)	0.3423	0.3413	0.3286	0.2961	0.3120	0.2722	0.3919	0.3961
10	Labour Productivity Ratio	2.9215	2.9303	3.0435	3.3772	3.2056	3.6735	2.5515	2.5245
11	Labour Productivity Indices / Observed Indices (O)	100.00	100.30	104.18	115.60	109.73	125.74	87.34	86.41
12	Computed Value/ Expected Values (E)	107.87	106.67	105.47	104.26	103.06	101.85	100.65	99.45
13	Chi-Square $(O-E)^2/E$	0.5749	0.3802	0.0158	1.2322	0.4312	5.6011	1.7614	1.7089

Average Labour Productivity Indices=103.66, a= 103.66, b =- 0.60, χ^2 =11.706, S.D.= 12.53, C.V.= 12.09%.

Analysis and Interpretation

Output: The output of Tata Consultancy Services Ltd. for the year 2010-11 is ₹ 29771.01 crore and reached to ₹ 82424.84 crore in 2017-18.

Salary, Wages, Bonus and Benefits: The salary, wages, bonus and benefits is ₹ 8884.06 crore in 2010-11 and reached to ₹ 29800.54 crore in 2017-18. Its input output ratio is the highest 0.3615 in 2017-18 while it is the lowest 0.2406 in 2015-16 indicates that salary, wages, bonus and benefits has optimally utilized in year 2015-16.

Contribution to Provident and Other Funds: It is ₹ 596.02 crore in 2010-11 and ₹ 2006.61 crore in 2017-18. Also its input output ratio is calculated which is the highest in 2016-17 and 2017-18 i.e. 0.0243 and the lowest in 2013-14 i.e. 0.0161.

Employees Welfare Expenses and Others: It is ₹ 710.23 crore in 2010-11 and reached to ₹ 843.22 crore in 2017-18. Its input output ratio is the lowest 0.0102 in 2016-17 and 2017-18.

Total Labour: Total labour input is ₹ 10190.31 crore in 2010-11 and reached to ₹ 32650.37 crore in 2017-18. Its input output ratio is 0.3423 in 2010-11 and reached to 0.3961 in 2017-18 indicating the highest 0.3961 in 2017-18 while the lowest 0.2722 in 2015-16.

Labour Productivity Ratio: Labour productivity ratio is the lowest 2.5245 in 2017-18 while it is the highest 3.6735 in 2015-16. The highest ratio reveals efficiency while the lowest ratio depicts that the labour input has not been utilized efficiently. Improvement in labour efficiency can also be observed from the average of labour indices which worked out as 103.66.

Testing Hypothesis and Interpretation: The standard deviation of Tata Consultancy Services Ltd. is 12.53 with 12.09 % of variability. For testing the hypothesis chi-square method has been used. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square is 11.706. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This reveals that the labour productivity ratios of the company for the eight year period are approximately the same and can be represented by straight line trend or line of best fit.

Table 5.11

Labour Productivity of Tech Mahindra Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	5092.10	4875.22	5073.86	13354.17	15545.48	18479.45	19799.98	20288.13
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	1744.60	1826.71	1902.67	4921.73	4685.16	4611.02	4650.13	4754.49
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.3426	0.3747	0.3750	0.3686	0.3014	0.2495	0.2349	0.2343
4	Contribution to Provident and Other Funds (₹ in Crore)	121.60	158.20	174.85	372.88	425.83	382.21	364.66	329.30
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0239	0.0325	0.0345	0.0279	0.0274	0.0207	0.0184	0.0162
6	Employees Welfare Expenses and Others (₹ in Crore)	77.60	92.76	26.53	24.64	52.27	38.23	34.56	55.73
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0152	0.0190	0.0052	0.0018	0.0034	0.0021	0.0017	0.0027
8	Total Labour Input (₹ in Crore)	1943.80	2077.67	2104.05	5319.25	5163.26	5031.46	5049.35	5139.52
9	Total Labour (Input Output Ratio)	0.3817	0.4262	0.4147	0.3983	0.3321	0.2723	0.2550	0.2533
10	Labour Productivity Ratio	2.6197	2.3465	2.4115	2.5105	3.0108	3.6728	3.9213	3.9475
11	Labour Productivity Indices / Observed Indices (O)	100.00	89.57	92.05	95.83	114.93	140.20	149.69	150.69
12	Computed Value/ Expected Values (E)	82.50	92.25	102.00	111.75	121.49	131.24	140.99	150.74
13	Chi-Square $(O-E)^2/E$	3.7127	0.0776	0.9695	2.2657	0.3547	0.6112	0.5361	0.0000

Average Labour Productivity Indices= 116.62, a= 116.62, b= 4.87, χ^2= 8.528, S.D. = 24.64, C.V. = 21.13 %.

Analysis and Interpretation

Output: The output of Tech Mahindra Ltd. exhibits an erratic trend. It is ₹ 5092.10 crore for the year 2010-11 and it reached to ₹ 20288.13 crore in 2017-18.

Salary, Wages, Bonus and Benefits: The salary, wages, bonus and benefits component of labour input of Tech Mahindra is the lowest ₹ 1744.60 crore in 2010-11 and the highest ₹ 4921.73 crore in 2013-14. Its input output ratio is showing a fluctuating trend. It is 0.3426 in 2010-11 and ultimately reached to 0.2343 in 2017-18. This means that for one rupee of output, 0.3426 as input is required in 2010-11 and so on.

Contribution to Provident and Other Funds: It is the lowest ₹ 121.60 crore in 2010-11 while its input output ratio is the lowest 0.0162 in 2017-18.

Employees Welfare Expenses and Others: Employees welfare expenses and others is the maximum ₹ 92.76 crore in 2011-12 while it is the minimum ₹ 24.64 crore in 2013-14. Its input output ratio is the maximum 0.0190 in 2011-12 while it is the minimum 0.0017 in 2016-17.

Total Labour: Total labour input of Tech Mahindra Ltd. is the highest ₹ 5319.25 crore in 2013-14 as compared to the lowest ₹ 1943.80 crore in 2010-11. Total labour input output ratio is the lowest in the year 2017-18 with 0.2533 indicating that total labour has been optimally utilized in this year.

Labour Productivity Ratio: Labour productivity ratio of Tech Mahindra Ltd. is more than one in all the years indicating optimum utilisation of labour cost by

Tech Mahindra Ltd. The highest labour productivity ratio is in 2017-18 with 3.9475 and the lowest is in 2011-12 with 2.3465. Improvement in labour efficiency can also be observed from the average of labour indices which worked out to 116.62 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Tech Mahindra Ltd. is 24.64 with coefficient of variation 21.13 %. Chi-square has been used for testing the hypothesis and its table value at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Tech Mahindra Ltd. is 8.528. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This exhibit that the labour productivity ratios of the company for the eight years period are approximately the same and can be represented by straight line trend or line of best fit.

Table 5.12

Labour Productivity of Wipro Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	26949.60	30252.87	29664.36	32941.35	35024.33	39676.31	40209.89	37750.59
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	10292.30	11685.64	12703.65	13392.40	13481.32	13726.12	13744.09	13289.72
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.3819	0.3863	0.4282	0.4066	0.3849	0.3460	0.3418	0.3520
4	Contribution to Provident and Other Funds (₹ in Crore)	378.20	316.68	330.03	308.18	267.23	383.02	68.26	89.58
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0140	0.0105	0.0111	0.0094	0.0076	0.0097	0.0017	0.0024
6	Employees Welfare Expenses and Others (₹ in Crore)	266.90	284.19	278.14	290.93	395.21	407.67	436.71	414.13
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0099	0.0094	0.0094	0.0088	0.0113	0.0103	0.0109	0.0110
8	Total Labour Input (₹ in Crore)	10937.40	12286.51	13311.82	13991.51	14143.76	14516.82	14249.07	13793.43
9	Total Labour (Input Output Ratio)	0.4058	0.4061	0.4487	0.4247	0.4038	0.3659	0.3544	0.3654
10	Labour Productivity Ratio	2.4640	2.4623	2.2284	2.3544	2.4763	2.7331	2.8219	2.7369
11	Labour Productivity Indices / Observed Indices (O)	100.00	99.93	90.44	95.55	100.50	110.92	114.53	111.07
12	Computed Value/ Expected Values (E)	93.83	96.41	99.00	101.58	104.16	106.74	109.32	111.91
13	Chi-Square $(O-E)^2/E$	0.4056	0.1284	0.7394	0.3574	0.1286	0.1638	0.2477	0.0062

Average Labour Productivity Indices = 102.87, a = 102.87, b = 1.29, χ^2 = 2.177, S.D. = 7.89, C.V. = 7.67 %.

Analysis and Interpretation

Output: The output of Wipro Ltd. lies between ₹ 26949.60 crore and ₹ 40209.89 crore.

Salary, Wages, Bonus and Benefits: The salary, wages, bonus and benefits of Wipro Ltd. is the maximum ₹ 13744.09 crore in 2016-17 while it is the minimum ₹ 10292.30 crore in 2010-11. The input output ratio is the lowest 0.3418 in 2016-17 while it is the highest 0.4282 in the year 2012-13. The lowest ratio indicates

that the salary, wages, bonus and benefits segment in labour input is best utilized in the year 2016-17.

Contribution to Provident and Other Funds: Contribution to provident and other funds lies between ₹ 68.26 crore and ₹ 383.02 crore. Also its input output ratio lies between 0.0017 and 0.0140.

Employees Welfare Expenses and Others: It is ₹ 266.90 crore in 2010-11 as compared to ₹ 414.13 crore in 2017-18. Its input output ratio is the highest 0.0113 in 2014-15 while it is the lowest 0.0088 in 2013-14.

Total Labour: Total labour input of Wipro Ltd. varies from ₹ 10937.40 crore to ₹ 14516.82 crore. Total labour input output ratio is the lowest 0.3544 in 2016-17 indicates that labour has been optimally utilized in the year 2016-17 as compared to the highest 0.4487 in 2012-13.

Labour Productivity Ratio: Labour productivity ratio is the highest 2.8219 in 2016-17 while it is the lowest 2.2284 in 2012-13. The highest labour productivity ratio is better as it gives more output with small amount of input. Labour efficiency can also be observed from the average of labour indices which worked out to 102.87 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Wipro Ltd. is 7.89 with 7.67 % of variability. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Wipro Ltd. is 2.177. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This conveys that the labour productivity indices of the Wipro Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

5.5.4. Labour Productivity of Metals Sector Companies

Labour productivity of metals sector companies has been highlighted from table 5.13 to 5.16.

Table 5.13

Labour Productivity of Coal India Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	5473.42	8752.79	9829.37	13365.32	11696.91	14394.79	12656.19	7972.12
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	181.25	192.98	193.56	193.88	181.24	173.65	166.00	168.62
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0331	0.0220	0.0197	0.0145	0.0155	0.0121	0.0131	0.0212
4	Contribution to Provident and Other Funds (₹ in Crore)	17.84	18.61	21.77	20.18	19.07	18.83	18.07	18.14
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0033	0.0021	0.0022	0.0015	0.0016	0.0013	0.0014	0.0023
6	Employees Welfare Expenses and Others (₹ in Crore)	52.02	73.66	74.91	56.81	62.53	65.08	86.92	146.11
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0095	0.0084	0.0076	0.0043	0.0053	0.0045	0.0069	0.0183
8	Total Labour Input (₹ in Crore)	251.11	285.24	290.24	270.87	262.84	257.56	270.99	332.88
9	Total Labour (Input Output Ratio)	0.0459	0.0326	0.0295	0.0203	0.0225	0.0179	0.0214	0.0418
10	Labour Productivity Ratio	21.7969	30.6853	33.8666	49.3431	44.5024	55.8895	46.7034	23.9493
11	Labour Productivity Indices / Observed Indices (O)	100.00	140.78	155.37	226.38	204.17	256.41	214.27	109.87
12	Computed Value/ Expected Values (E)	146.01	154.55	163.09	171.64	180.18	188.72	197.26	205.80
13	Chi-Square $(O-E)^2/E$	14.4993	1.2277	0.3655	17.4592	3.1947	24.2810	1.4663	44.7120

Average Labour Productivity Indices=175.91, a= 175.91, b= 4.27, χ^2= 107.206, S.D.= 53.71, C.V.=30.53 %.

Analysis and Interpretation

Output: The output of Coal India Ltd. is changeful in nature. It is the lowest ₹ 5473.42 crore in 2010-11 and it is the highest ₹ 14394.79 crore in 2015-16.

Salary, Wages, Bonus and Benefits: It is regarded as the most important element of labour input. It is ₹ 181.25 crore in 2010-11 and reached to ₹ 168.62 crore in 2017-18. Its input output ratio is the highest 0.0331 in 2010-11 while it is the lowest 0.0121 in 2015-16.

Contribution to Provident and Other Funds: It is the highest ₹ 21.77 crore in 2012-13 while it is the lowest ₹ 17.84 crore in 2010-11. Its input output ratio is the lowest 0.0013 in 2015-16 as compared to the highest 0.0033 in 2010-11.

Employees Welfare Expenses and Others: It ranges from ₹ 52.02 crore in 2010-11 to ₹ 146.11 crore in 2017-18. Input output ratio of employee welfare expenses and others is the lowest 0.0043 in 2013-14 indicates optimum utilisation.

Total Labour: Total labour input is ₹ 251.11 crore in 2010-11 and reached to ₹ 332.88 crore in 2017-18. Its input output ratio is the highest 0.0459 in 2010-11 while it is the lowest 0.0179 in 2015-16. The lowest labour input output ratio means labour input has been best utilized in the year 2015-16.

Labour Productivity Ratio: There is an inconsistent trend in the labour productivity ratio of Coal India Ltd. It is the lowest 21.7969 in 2010-11 while it is the highest 55.8895 in 2015-16. Improvement in labour efficiency can also be

observed from the average of labour indices which worked out to 175.91 which is much higher than the base year index of 100.

Testing Hypothesis and Interpretation: In Coal India Ltd. the standard deviation calculated is 53.71 and coefficient of variation is 30.53 % highlights variability. The computed value of chi-square is 107.206 while the table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This reveals that the labour productivity indices of the company for the study period are not same and cannot be represented by straight line trend or line of best fit.

Table 5.14

Labour Productivity of Hindalco Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	23812.03	24607.23	23337.28	23092.10	28592.89	29776.75	30320.65	34617.98
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	788.98	821.81	813.19	819.36	873.71	929.78	939.43	983.31
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0331	0.0334	0.0348	0.0355	0.0306	0.0312	0.0310	0.0284
4	Contribution to Provident and Other Funds (₹ in Crore)	146.57	110.82	98.51	114.60	163.47	119.07	98.43	113.36
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0062	0.0045	0.0042	0.0050	0.0057	0.0040	0.0032	0.0033
6	Employees Welfare Expenses and Others (₹ in Crore)	104.84	94.99	93.38	93.11	102.48	104.14	104.53	104.54
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0044	0.0039	0.0040	0.0040	0.0036	0.0035	0.0034	0.0030
8	Total Labour Input (₹ in Crore)	1040.39	1027.62	1005.07	1027.07	1139.66	1152.98	1142.38	1201.21
9	Total Labour (Input Output Ratio)	0.0437	0.0418	0.0431	0.0445	0.0399	0.0387	0.0377	0.0347
10	Labour Productivity Ratio	22.8876	23.9458	23.2196	22.4834	25.0890	25.8258	26.5416	28.8193
11	Labour Productivity Indices / Observed Indices (O)	100.00	104.62	101.45	98.23	109.62	112.84	115.96	125.92
12	Computed Value/ Expected Values (E)	96.76	100.14	103.52	106.89	110.27	113.65	117.02	120.40
13	Chi-Square $(O-E)^2/E$	0.1084	0.2009	0.0412	0.7013	0.0038	0.0058	0.0096	0.2527

Average Labour Productivity Indices = 108.58, a = 108.58, b = 1.69, χ^2 = 1.324, S.D. = 8.81, C.V. = 8.12 %.

Analysis and Interpretation

Output: The revalued output of Hindalco Ltd. is ₹ 23812.03 crore in 2010-11 and reached to ₹ 34617.98 crore in 2017-18.

Salary, Wages, Bonus and Benefits: It is the highest ₹ 983.31 crore in 2017-18 and the lowest ₹ 788.98 crore in 2010-11. Its input output ratio is the highest 0.0355 in 2013-14 while it is the lowest 0.0284 in 2017-18.

Contribution to Provident and Other Funds: It is the highest ₹ 163.47 crore in 2014-15 while it is the lowest ₹ 98.43 crore in 2016-17. Input output ratio of contribution to provident and other funds is the lowest 0.0032 in 2016-17 while it is the highest 0.0062 in 2010-11.

Employees Welfare Expenses and Others: It is the lowest ₹ 93.11 crore in 2013-14 as compared to the highest ₹ 104.84 crore in 2010-11. Input output ratio is the lowest 0.0030 in 2017-18 indicating that less has been expended on employees welfare and others.

Total Labour: Total labour input consumption of Hindalco Ltd. is ₹ 1040.39 crore in 2010-11, then it is decreased and reached to ₹ 1005.07 crore in 2012-13, then it increased and reached to ₹ 1152.98 crore in 2015-16 then after fluctuation ultimately reached to ₹ 1201.21 crore in 2017-18. Total labour input output ratio is the lowest 0.0347 in 2017-18 while it is the highest 0.0445 in 2013-14.

Labour Productivity Ratio: Labour productivity ratio is the lowest 22.4834 in 2013-14 while it is the highest 28.8193 in 2017-18. The highest ratio indicates efficiency and effectiveness as compared to others. Labour efficiency can also be observed from the average of labour indices which worked out to 108.58 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: Standard deviation of Hindalco Ltd. is 8.81 while its coefficient of variation is 8.12 %. The computed value of chi-square is 1.324. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the labour productivity indices of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 5.15

Labour Productivity of Tata Steel Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	29751.06	31762.04	33240.61	34552.29	33571.38	35358.24	43080.57	49400.88
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	2106.52	2442.45	2441.27	2464.95	2558.87	2449.69	2565.35	2618.85
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0708	0.0769	0.0734	0.0713	0.0762	0.0693	0.0595	0.0530
4	Contribution to Provident and Other Funds (₹ in Crore)	491.94	276.24	350.62	279.18	430.30	315.49	283.16	283.24
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0165	0.0087	0.0105	0.0081	0.0128	0.0089	0.0066	0.0057
6	Employees Welfare Expenses and Others (₹ in Crore)	239.00	93.92	223.21	58.43	310.40	171.43	154.04	159.40
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0080	0.0030	0.0067	0.0017	0.0092	0.0048	0.0036	0.0032
8	Total Labour Input (₹ in Crore)	2837.46	2812.62	3015.10	2802.56	3299.58	2936.61	3002.54	3061.49
9	Total Labour (Input Output Ratio)	0.0954	0.0886	0.0907	0.0811	0.0983	0.0831	0.0697	0.0620
10	Labour Productivity Ratio	10.4851	11.2927	11.0247	12.3288	10.1745	12.0405	14.3480	16.1362
11	Labour Productivity Indices / Observed Indices (O)	100.00	107.70	105.15	117.58	97.04	114.83	136.84	153.90
12	Computed Value/ Expected Values (E)	94.48	100.81	107.14	113.47	119.79	126.12	132.45	138.78
13	Chi-Square $(O-E)^2/E$	0.3219	0.4709	0.0371	0.1494	4.3230	1.0101	0.1457	1.6475

Average Labour Productivity Indices= 116.63, a= 116.63, b= 3.16, χ^2= 8.106, S.D. = 18.28, C.V. = 15.67 %.

Analysis and Interpretation

Output: The output of Tata Steel Ltd. is ₹ 29751.06 crore in 2010-11 and reached to ₹ 49400.88 crore in 2017-18.

Salary, Wages, Bonus and Benefits: It is ₹ 2106.52 crore in 2010-11 and reached to ₹ 2618.85 crore in 2017-18. Its input output ratio is the highest 0.0769 in 2011-12 while it is the lowest 0.0530 in 2017-18. The lowest salary, wages, bonus and benefits input output ratio indicates optimum labour utilisation has been achieved in the year 2017-18.

Contribution to Provident and Other Funds: Contribution to provident and other funds consumption is the highest ₹ 491.94 crore in 2010-11 while it is the lowest ₹ 276.24 crore in 2011-12. Its input output ratio is the lowest 0.0057 in 2017-18 as compared to the highest 0.0165 in 2010-11.

Employees Welfare Expenses and Others: It is the highest ₹ 310.40 crore in 2014-15 while it is the lowest ₹ 58.43 crore in 2013-14. Its input output ratio is the lowest 0.0017 in 2013-14 while it is the highest 0.0092 in 2014-15.

Total Labour: Total labour input of Tata Steel Ltd. range between ₹ 2802.56 crore to ₹ 3299.58 crore. It is the lowest in 2013-14 while the highest in 2014-15. Total labour input output ratio is the highest 0.0983 in 2014-15 while it is the lowest 0.0620 in 2017-18. The lowest labour input output ratio means labour has been optimally utilized in the year 2017-18 indicating that there is neither over labour in the organisation nor the labour is remained idle.

Labour Productivity Ratio: Labour productivity ratio of Tata Steel Ltd. is the lowest 10.1745 in 2014-15 and the highest 16.1362 in 2017-18. Improvement in labour efficiency can also be observed from the average of labour indices which is 116.63 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Tata Steel Ltd. is 18.28 with 15.67 % of variability. The computed value of chi-square is 8.106 as compared to the table value 14.067 at 5% level of significance with (8-1) = 7 degree of freedom. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted. This demonstrates that the labour productivity indices of the Tata Steel Ltd. for the study period are

approximately same and can be represented by straight line trend or line of best fit.

Table 5.16

Labour Productivity of Vedanta Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	7996.15	6378.58	2133.63	24314.13	28028.71	32447.13	37817.67	39453.82
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	121.58	143.73	128.88	372.78	412.15	361.78	370.34	365.82
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0152	0.0225	0.0604	0.0153	0.0147	0.0111	0.0098	0.0093
4	Contribution to Provident and Other Funds (₹ in Crore)	13.53	16.31	14.36	25.87	24.38	17.84	52.16	53.89
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0017	0.0026	0.0067	0.0011	0.0009	0.0005	0.0014	0.0014
6	Employees Welfare Expenses and Others (₹ in Crore)	13.97	16.66	11.28	27.93	29.62	30.17	88.67	88.76
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0017	0.0026	0.0053	0.0011	0.0011	0.0009	0.0023	0.0022
8	Total Labour Input (₹ in Crore)	149.08	176.70	154.53	426.58	466.14	409.80	511.17	508.47
9	Total Labour (Input Output Ratio)	0.0186	0.0277	0.0724	0.0175	0.0166	0.0126	0.0135	0.0129
10	Labour Productivity Ratio	53.6366	36.0985	13.8075	56.9981	60.1290	79.1786	73.9829	77.5935
11	Labour Productivity Indices / Observed Indices (O)	100.00	67.30	25.74	106.27	112.10	147.62	137.93	144.67
12	Computed Value/ Expected Values (E)	61.98	74.33	86.68	99.03	111.38	123.73	136.08	148.42
13	Chi-Square $(O-E)^2/E$	23.3156	0.6650	42.8412	0.5289	0.0047	4.6140	0.0254	0.0952

Average Labour Productivity Indices=105.20, a=105.20, b= 6.17, χ^2 =72.090, S.D. = 39.14, C.V. = 37.20 %.

Analysis and Interpretation

Output: The output of Vedanta Ltd. is the highest ₹ 39453.82 crore in 2017-18 while it is the lowest ₹ 2133.63 crore in 2012-13.

Salary, Wages, Bonus and Benefits: It is the highest ₹ 412.15 crore in 2014-15 and the lowest ₹ 121.58 crore in 2010-11. Its input output ratio is the highest 0.0604 in 2012-13 while it is the lowest 0.0093 in 2017-18.

Contribution to Provident and Other Funds: Its consumption is the lowest ₹ 13.53 crore in 2010-11 while it is the highest ₹ 53.89 crore in 2017-18. Input output ratio of contribution to provident and other funds is the lowest 0.0005 in 2015-16 as compared to the highest 0.0067 in 2012-13.

Employees Welfare Expenses and Others: It is the lowest ₹ 11.28 crore in 2012-13 as compared to ₹ 88.76 crore in 2017-18. Its input output ratio is the lowest 0.0009 in 2015-16 indicates less has been expended on employees welfare and others. It is the highest 0.0053 in 2012-13.

Total Labour: Total labour input consumption of Vedanta Ltd. is ₹ 149.08 crore in 2010-11 then it ultimately reached to ₹ 508.47 crore in 2017-18. Total labour input output ratio is the highest 0.0724 in 2012-13 while it is the lowest 0.0126 in 2015-16.

Labour Productivity Ratio: Labour productivity ratio of Vedanta Ltd. is 53.6366 in 2010-11, 36.0985 in 2011-12, 13.8075 in 2012-13, 56.9981 in 2013-14, 60.1290 in 2014-15, 79.1786 in 2015-16, 73.9829 in 2016-17 and 77.5935 in 2017-18. Labour productivity ratio is the lowest 13.8075 in 2012-13 while it is the highest 79.1786 in 2015-16. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the labour input has not been utilized efficiently as compared to other years. Labour efficiency can also be analysed from the average of labour indices. It is 105.20 which is higher than the base year index of 100. This indicates that on an average labour is utilized efficiently in all the years.

Testing Hypothesis and Interpretation: The standard deviation of Vedanta Ltd. is 39.14 with coefficient of variation 37.20 %. The computed value of chi-square is 72.090. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This reveals that the labour productivity indices of the Vedanta Ltd. for the study period are not same and cannot be represented by straight line trend or line of best fit.

5.5.5 Labour Productivity of Pharmaceutical Sector Companies

Labour productivity of pharmaceutical sector companies has been displayed from table 5.17 to 5.20.

Table 5.17

Labour Productivity of Cipla Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	6308.14	6551.80	6992.95	7754.00	8004.10	10480.54	9185.26	9242.54
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	394.44	590.10	714.25	820.32	902.71	1031.63	1004.17	1003.60
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0625	0.0901	0.1021	0.1058	0.1128	0.0984	0.1093	0.1086
4	Contribution to Provident and Other Funds (₹ in Crore)	26.16	31.73	37.16	41.66	45.70	50.58	71.53	63.47
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0041	0.0048	0.0053	0.0054	0.0057	0.0048	0.0078	0.0069
6	Employees Welfare Expenses and Others (₹ in Crore)	43.60	50.30	59.87	118.29	131.09	132.96	51.59	65.22
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0069	0.0077	0.0086	0.0153	0.0164	0.0127	0.0056	0.0071
8	Total Labour Input (₹ in Crore)	464.20	672.14	811.29	980.26	1079.50	1215.17	1127.29	1132.29
9	Total Labour (Input Output Ratio)	0.0736	0.1026	0.1160	0.1264	0.1349	0.1159	0.1227	0.1225
10	Labour Productivity Ratio	13.5893	9.7477	8.6196	7.9101	7.4146	8.6247	8.1481	8.1627
11	Labour Productivity Indices / Observed Indices (O)	100.00	71.73	63.43	58.21	54.56	63.47	59.96	60.07
12	Computed Value/ Expected Values (E)	80.67	76.60	72.53	68.46	64.39	60.32	56.25	52.18
13	Chi-Square $(O-E)^2/E$	4.6293	0.3100	1.1428	1.5360	1.5008	0.1639	0.2444	1.1917

Average Labour Productivity Indices=66.43, a = 66.43, b = - 2.04, χ^2 = 10.719, S.D. = 13.53, C.V. = 20.36 %.

Analysis and Interpretation

Output: The revalued output of Cipla Ltd. has an increasing trend except in the year 2016-17 and 2017-18. It is the highest ₹ 10480.54 crore in 2015-16 and it is the lowest ₹ 6308.14 crore in 2010-11.

Salary, Wages, Bonus and Benefits: It is ₹ 394.44 crore in 2010-11, ₹ 590.10 crore in 2011-12, ₹ 714.25 crore in 2012-13, ₹ 820.32 crore in 2013-14, ₹ 902.71 crore in 2014-15, ₹ 1031.63 crore in 2015-16, ₹ 1004.17 crore in 2016-17 and ₹ 1003.60 crore in 2017-18. Its input output ratio is the highest 0.1128 in 2014-15 while it is the lowest 0.0625 in 2010-11.

Contribution to Provident and Other Funds: Another section of the total labour input is contribution to provident and other funds. It is the minimum ₹ 26.16 crore in 2010-11 and the maximum ₹ 71.53 crore in 2016-17. Its input output ratio is the lowest 0.0041 in 2010-11 as compared to the highest 0.0078 in 2016-17.

Employees Welfare Expenses and Others: It is ₹ 43.60 crore in 2010-11, ₹ 50.30 crore in 2011-12, ₹ 59.87 crore in 2012-13, ₹ 118.29 crore in 2013-14, ₹ 131.09 crore in 2014-15, ₹ 132.96 crore in 2015-16, ₹ 51.59 crore in 2016-17 and ₹ 65.22 crore in 2017-18. Its input output ratio is the lowest 0.0056 in 2016-17 while it is the highest 0.0164 in 2014-15.

Total Labour: Total labour input is ₹ 464.20 crore in 2010-11, ₹ 672.14 crore in 2011-12, ₹ 811.29 crore in 2012-13, ₹ 980.26 crore in 2013-14, ₹ 1079.50 crore in 2014-15, ₹ 1215.17 crore in 2015-16, ₹ 1127.29 in 2016-17 and ₹ 1132.29 crore in 2017-18 respectively. The lowest labour input output ratio is in the year 2010-11 with 0.0736 indicates labour has been best utilized in this year.

Labour Productivity Ratio: Labour productivity ratio is 13.5893 in 2010-11, 9.7477 in 2011-12, 8.6196 in 2012-13, 7.9101 in 2013-14, 7.4146 in 2014-15, 8.6247 in 2015-16, 8.1481 in 2016-17 and 8.1627 in 2017-18. Labour productivity ratio is the lowest 7.4146 in 2014-15 while it is the highest 13.5893 in 2010-11. Improvement in labour efficiency can also be observed from the average of labour indices which worked out to 66.43 as compared to the base year index of 100 which is very low.

Testing Hypothesis and Interpretation: The standard deviation is 13.53 with 20.36 % of variability. The table value of chi-square at 5% level of significance

with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Cipla Ltd. is 10.719. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This reveals that the labour productivity indices of the Cipla Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 5.18

Labour Productivity of Dr. Reddy's Laboratories Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	5345.10	6165.93	7280.11	7922.46	8225.15	8724.64	8487.52	7599.85
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	566.10	660.50	789.96	748.05	878.83	973.62	997.04	990.12
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.1059	0.1071	0.1085	0.0944	0.1068	0.1116	0.1175	0.1303
4	Contribution to Provident and Other Funds (₹ in Crore)	39.50	32.58	47.46	42.12	52.20	70.34	65.33	69.30
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0074	0.0053	0.0065	0.0053	0.0063	0.0081	0.0077	0.0091
6	Employees Welfare Expenses and Others (₹ in Crore)	95.60	106.33	115.17	113.92	137.95	117.13	113.38	109.05
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0179	0.0172	0.0158	0.0144	0.0168	0.0134	0.0134	0.0143
8	Total Labour Input (₹ in Crore)	701.20	799.41	952.59	904.08	1068.98	1161.09	1175.75	1168.46
9	Total Labour (Input Output Ratio)	0.1312	0.1296	0.1308	0.1141	0.1300	0.1331	0.1385	0.1537
10	Labour Productivity Ratio	7.6228	7.7131	7.6424	8.7630	7.6944	7.5142	7.2188	6.5041
11	Labour Productivity Indices / Observed Indices (O)	100.00	101.18	100.26	114.96	100.94	98.58	94.70	85.33
12	Computed Value/ Expected Values (E)	105.92	104.08	102.25	100.41	98.57	96.74	94.90	93.07
13	Chi-Square $(O-E)^2/E$	0.3307	0.0807	0.0387	2.1077	0.0567	0.0349	0.0004	0.6440

Average Labour Productivity Indices = 99.49, a = 99.49, b = - 0.92, χ^2 = 3.294, S.D. = 7.66, C.V. = 7.70 %.

Analysis and Interpretation

Output: The revalued output of Dr. Reddy's Laboratories Ltd. for the year 2010-11 is ₹ 5345.10 crore, for year 2011-12 output becomes ₹ 6165.93 crore, for 2012-13 it is ₹ 7280.11 crore, for 2013-14 ₹ 7922.46 crore, for 2014-15 ₹ 8225.15 crore, for 2015-16 output is ₹ 8724.64 crore, for 2016-17 output is ₹ 8487.52 crore and for 2017-18 it is ₹ 7599.85 crore.

Salary, Wages, Bonus and Benefits: The salary, wages, bonus and benefits is ₹ 566.10 crore, ₹ 660.50 crore, ₹ 789.96 crore, ₹ 748.05 crore, ₹ 878.83 crore, ₹ 973.62 crore, ₹ 997.04 crore and ₹ 990.12 crore respectively from 2010-11 to 2017-18. Its input output ratio is the highest 0.1303 in 2017-18 while it is the lowest 0.0944 in 2013-14 indicates that salary, wages, bonus and benefits segment of labour input has optimally utilized in year 2013-14.

Contribution to Provident and Other Funds: Another segment to discuss in the total labour input is contribution to provident and other funds. It is ₹ 39.50 crore

in 2010-11, ₹ 32.58 crore in 2011-12, ₹ 47.46 crore in 2012-13, ₹ 42.12 crore in 2013-14, ₹ 52.20 crore in 2014-15 and ₹ 70.34 crore in 2015-16, ₹ 65.33 crore in 2016-17 and ₹ 69.30 crore in 2017-18. Also its input output ratio is calculated which is the highest in 2017-18 with 0.0091 and the lowest in 2011-12 and 2013-14 with 0.0053.

Employees Welfare Expenses and Others: It is ₹ 95.60 crore in 2010-11 and reached to ₹ 109.05 crore in 2017-18. Its input output ratio is 0.0179 in 2010-11, 0.0172 in 2011-12, 0.0158 in 2012-13, 0.0144 in 2013-14, 0.0168 in 2014-15, 0.0134 in 2015-16, 2016-17 and 0.0143 in 2017-18. It is the lowest 0.0134 in 2015-16 and 2016-17.

Total Labour: Total labour input is ₹ 701.20 crore in 2010-11 and reached to ₹ 1168.46 crore in 2017-18. Its input output ratio is 0.1312 in 2010-11 and reached to 0.1537 in 2017-18 indicating the highest 0.1537 in 2017-18 while the lowest 0.1141 in 2013-14.

Labour Productivity Ratio: Labour productivity ratio is 7.6228 in 2010-11, 7.7131 in 2011-12, 7.6424 in 2012-13, 8.7630 in 2013-14, 7.6944 in 2014-15, 7.5142 in 2015-16, 7.2188 in 2016-17 and lastly it is 6.5041 in 2017-18. Labour productivity ratio is the lowest 6.5041 in 2017-18 while it is the highest 8.7630 in 2013-14. Improvement in labour efficiency can also be observed from the average of labour indices which is 99.49.

Testing Hypothesis and Interpretation: The standard deviation of Dr. Reddy's Laboratories Ltd. is 7.66 with 7.70 % of variability. For testing the hypothesis chi-square method has been used. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Dr. Reddy's Laboratories Ltd. is 3.294. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This reveals that the labour productivity ratios of the Dr. Reddy's Laboratories Ltd. for the eight year period are approximately the same and can be represented by straight line trend or line of best fit.

Table 5.19

Labour Productivity of Lupin Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	4510.95	4824.82	5981.54	7571.30	7868.41	9452.23	10416.18	8232.87
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	417.30	450.51	506.88	528.68	585.12	660.52	743.80	745.96
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0925	0.0934	0.0847	0.0698	0.0744	0.0699	0.0714	0.0906
4	Contribution to Provident and Other Funds (₹ in Crore)	46.70	48.72	50.59	52.67	69.84	66.47	63.04	71.75
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0104	0.0101	0.0085	0.0070	0.0089	0.0070	0.0061	0.0087
6	Employees Welfare Expenses and Others (₹ in Crore)	27.23	37.24	39.38	62.87	99.72	81.47	107.95	96.29
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0060	0.0077	0.0066	0.0083	0.0127	0.0086	0.0104	0.0117
8	Total Labour Input (₹ in Crore)	491.23	536.47	596.85	644.22	754.68	808.46	914.78	914.00
9	Total Labour (Input Output Ratio)	0.1089	0.1112	0.0998	0.0851	0.0959	0.0855	0.0878	0.1110
10	Labour Productivity Ratio	9.1830	8.9937	10.0219	11.7527	10.4262	11.6917	11.3866	9.0075
11	Labour Productivity Indices / Observed Indices (O)	100.00	97.94	109.14	127.98	113.54	127.32	124.00	98.09
12	Computed Value/ Expected Values (E)	105.71	107.58	109.45	111.32	113.18	115.05	116.92	118.79
13	Chi-Square $(O-E)^2/E$	0.3082	0.8635	0.0009	2.4959	0.0011	1.3075	0.4279	3.6082

Average Labour Productivity Indices= 112.25, a= 112.25, b = 0.93, χ^2 = 9.013, S.D. = 12.14, C.V. = 10.82 %.

Analysis and Interpretation

Output: The output of Lupin Ltd. depicting an upward trend. It is ₹ 4510.95 crore for the year 2010-11 and it reached to ₹ 8232.87 crore in 2017-18.

Salary, Wages, Bonus and Benefits: The salary, wages, bonus and benefits are forming the major part of the labour input of Lupin Ltd. It is ₹ 417.30 crore in 2010-11, ₹ 450.51 crore in 2011-12, ₹ 506.88 crore in 2012-13, ₹ 528.68 crore in 2013-14, ₹ 585.12 crore in 2014-15, ₹ 660.52 crore in 2015-16, ₹ 743.80 crore in 2016-17 and ₹ 745.96 crore in 2017-18. Its input output ratio is showing a fluctuating trend with 0.0925 in 2010-11, 0.0934 in 2011-12, 0.0847 in 2012-13, 0.0698 in 2013-14, 0.0744 in 2014-15, 0.0699 in 2015-16, 0.0714 in 2016-17 and 0.0906 in 2017-18. This means that for one rupee of output, 0.0925 as input is required in 2010-11 and so on.

Contribution to Provident and Other Funds: It is ₹ 46.70 crore in 2010-11 and reached to ₹ 71.75 crore in 2017-18. Its input output ratio is 0.0104, 0.0101, 0.0085, 0.0070, 0.0089, 0.0070, 0.0061 and 0.0087 respectively from 2010-11 to 2017-18. It is the highest 0.0104 in 2010-11 while it is the lowest in 0.0061 in 2016-17.

Employees Welfare Expenses and Others: Employees welfare expenses and others is ₹ 27.23 crore in 2010-11, ₹ 37.24 crore in 2011-12, ₹ 39.38 crore in 2012-13, ₹ 62.87 crore in 2013-14, ₹ 99.72 crore in 2014-15, ₹ 81.47 crore in 2015-16, ₹ 107.95 crore in 2016-17 and ₹ 96.29 crore in 2017-18. Input output

ratio is the lowest 0.0060 in 2010-11 and reached to the highest 0.0127 in 2014-15.

Total Labour: Total labour input of Lupin Ltd. is showing an upward trend except in the year 2017-18. It is the highest ₹ 914.78 crore in 2016-17 as compared to the lowest ₹ 491.23 crore in 2010-11. Total labour input output ratio 0.1089 in 2010-11, 0.1112 in 2011-12, 0.0998 in 2012-13, 0.0851 in 2013-14, 0.0959 in 2014-15, 0.0855 in 2015-16, 0.0878 in 2016-17 and 0.1110 in 2017-18 respectively. Total labour input output ratio is the lowest in the year 2013-14 with 0.0851 indicating that total labour has been optimally utilized in this year.

Labour Productivity Ratio: Labour productivity ratio is 9.1830 in 2010-11, decreased to 8.9937 in 2011-12, then it slightly increased to 10.0219 in 2012-13, again increased to 11.7527 in 2013-14, then it lowered down to 10.4262 in 2014-15, again it increased to 11.6917 in 2015-16, 11.3866 in 2016-17, then ultimately reached to 9.0075 in 2017-18. The highest labour productivity ratio in 2013-14 with 11.7527 indicates that labour has been best utilized in the year 2013-14. Improvement in labour efficiency can also be observed from the average of labour indices which worked out to 112.25 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Lupin Ltd. is 12.14 with coefficient of variation 10.82 %. Chi-square has been used for testing the hypothesis and its table value at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Lupin Ltd. is 9.013. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This reveals that the labour productivity ratios of the Lupin Ltd. for the eight year period are approximately the same and can be represented by straight line trend or line of best fit.

Table 5.20

Labour Productivity of Sun Pharmaceutical Industries Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	3300.23	3925.99	2283.03	2426.49	6888.78	6677.42	6699.57	7378.69
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	176.17	250.02	152.90	179.21	917.16	859.71	898.39	936.15
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0534	0.0637	0.0670	0.0739	0.1331	0.1287	0.1341	0.1269
4	Contribution to Provident and Other Funds (₹ in Crore)	11.88	15.74	16.77	10.39	69.84	76.88	53.84	66.06
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0036	0.0040	0.0073	0.0043	0.0101	0.0115	0.0080	0.0090
6	Employees Welfare Expenses and Others (₹ in Crore)	26.01	26.43	26.92	23.76	78.95	68.67	25.69	23.41
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0079	0.0067	0.0118	0.0098	0.0115	0.0103	0.0038	0.0032
8	Total Labour Input (₹ in Crore)	214.06	292.18	196.59	213.36	1065.95	1005.27	977.92	1025.62
9	Total Labour (Input Output Ratio)	0.0649	0.0744	0.0861	0.0879	0.1547	0.1505	0.1460	0.1390
10	Labour Productivity Ratio	15.4173	13.4367	11.6134	11.3729	6.4626	6.6424	6.8508	7.1944
11	Labour Productivity Indices / Observed Indices (O)	100.00	87.15	75.33	73.77	41.92	43.08	44.44	46.66
12	Computed Value/ Expected Values (E)	93.86	85.34	76.82	68.30	59.78	51.27	42.75	34.23
13	Chi-Square $(O-E)^2/E$	0.4021	0.0386	0.0290	0.4371	5.3397	1.3059	0.0666	4.5164

Average Labour Productivity Indices=64.04, a = 64.04, b = - 4.26, χ^2 = 12.135, S.D. = 21.40, C.V. = 33.42 %.

Analysis and Interpretation

Output: The output of Sun Pharmaceutical Industries Ltd. showing a fluctuating trend. Output in 2010-11 is ₹ 3300.23 crore, in 2011-12 ₹ 3925.99 crore, in 2012-13 ₹ 2283.03 crore, in 2013-14 ₹ 2426.49 crore, in 2014-15 ₹ 6888.78 crore, in 2015-16 ₹ 6677.42 crore, in 2016-17 ₹ 6699.57 crore, in 2017-18 ₹ 7378.69 crore.

Salary, Wages, Bonus and Benefits: The salary, wages, bonus and benefits of Sun Pharmaceutical Industries Ltd. is ₹ 176.17 crore in 2010-11, ₹ 250.02 crore in 2011-12, ₹ 152.90 crore in 2012-13, ₹ 179.21 crore in 2013-14, ₹ 917.16 crore in 2014-15, ₹ 859.71 crore in 2015-16, ₹ 898.39 crore in 2016-17 and ₹ 936.15 crore in 2017-18. Salary, wages, bonus and benefits are highly consumed after the year 2013-14. The input output ratio is the lowest 0.0534 in 2010-11 while it is the highest 0.1341 in the year 2016-17. The lowest ratio exhibits that the salary, wages, bonus and benefits element in labour input is best utilized in the year 2010-11.

Contribution to Provident and Other Funds: Contribution to provident and other funds is ₹ 11.88 crore in 2010-11 and reached to ₹ 66.06 crore in 2017-18. Also its input output ratio is 0.0036 in 2010-11 and reached to 0.0090 in 2017-18. It is the lowest 0.0036 in 2010-11 which elaborates that for every ₹ of output produced ₹ 0.0036 of input is required.

Employees Welfare Expenses and Others: It is ₹ 26.01 crore in 2010-11 as compared to ₹ 23.41 crore in 2017-18. Its input output ratio is the highest 0.0118 in 2012-13 while it is the lowest 0.0032 in 2017-18.

Total Labour: Total labour input of Sun Pharmaceutical Industries Ltd. is showing an erratic trend. It varies from ₹ 196.59 crore to ₹ 1065.95 crore. It is the lowest in 2012-13 while it is the highest in 2014-15. Total labour input output ratio is 0.0649 in 2010-11, 0.0744 in 2011-12, 0.0861 in 2012-13, 0.0879 in 2013-14, 0.1547 in 2014-15, 0.1505 in 2015-16, 0.1460 in 2016-17, 0.1390 in 2017-18 respectively. Total labour input output ratio is the lowest 0.0649 in 2010-11 indicates that labour has been optimally utilized in the year 2010-11. Labour efficiency can also be observed from the average of labour indices which worked out to 64.04 as compared to the base year index of 100. This indicates that labour is not being able to utilize efficiently as compared to the base year.

Labour Productivity Ratio: Labour productivity ratio is the highest 15.4173 in 2010-11 which means that for every ₹ of labour input approximately ₹ 15 of output is obtained. It is the lowest 6.4626 in 2014-15 which means that for every ₹ of labour input approximately ₹ 6 of output is obtained. So the highest labour productivity ratio is better as it gives more output with small amount of input.

Testing Hypothesis and Interpretation: The standard deviation of Sun Pharmaceutical Industries Ltd. is 21.40 with 33.42 % of variability. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Sun Pharmaceutical Industries Ltd. is 12.135. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This reveals that the labour productivity indices of the Sun Pharmaceutical Industries Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

5.5.6 Labour Productivity of Refineries Sector Companies

Labour productivity of refineries sector companies has been exhibited from table 5.21 to 5.24.

Table 5.21

Labour Productivity of Bharat Petroleum Corporation Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	151243.98	195601.15	206438.48	211751.09	197308.95	160737.40	163969.29	191476.02
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	1507.28	1552.71	1793.44	1657.02	1002.20	1395.67	1473.49	1594.03
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0100	0.0079	0.0087	0.0078	0.0051	0.0087	0.0090	0.0083
4	Contribution to Provident and Other Funds (₹ in Crore)	969.09	252.80	276.70	251.32	163.00	289.51	523.55	239.54
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0064	0.0013	0.0013	0.0012	0.0008	0.0018	0.0032	0.0013
6	Employees Welfare Expenses and Others (₹ in Crore)	326.48	281.46	247.41	301.57	330.18	269.70	238.96	341.66
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0022	0.0014	0.0012	0.0014	0.0017	0.0017	0.0015	0.0018
8	Total Labour Input (₹ in Crore)	2802.85	2086.97	2317.54	2209.92	1495.38	1954.87	2236.01	2175.24
9	Total Labour (Input Output Ratio)	0.0185	0.0107	0.0112	0.0104	0.0076	0.0122	0.0136	0.0114
10	Labour Productivity Ratio	53.9608	93.7251	89.0764	95.8187	131.9461	82.2239	73.3313	88.0252
11	Labour Productivity Indices / Observed Indices (O)	100.00	173.69	165.08	177.57	244.52	152.38	135.90	163.13
12	Computed Value/ Expected Values (E)	152.29	155.65	159.00	162.36	165.71	169.06	172.42	175.77
13	Chi-Square $(O-E)^2/E$	17.9553	2.0920	0.2321	1.4259	37.4832	1.6472	7.7361	0.9098

Average Labour Productivity Indices=164.03, a= 164.03, b= 1.68, χ^2 = 69.482, S.D. = 38.38, C.V. = 23.40 %.

Analysis and Interpretation

Output: The revalued output of Bharat Petroleum Corporation Ltd. is conveying a fluctuating trend. It is the highest ₹ 211751.09 crore in 2013-14 and it is the lowest ₹ 151243.98 crore in 2010-11.

Salary, Wages, Bonus and Benefits: It is regarded as the significant chunk. It is ₹ 1507.28 crore in 2010-11 and reached to ₹ 1594.03 crore in 2017-18. Its input output ratio is the highest 0.0100 in 2010-11 while it is the lowest 0.0051 in 2014-15. The lowest salary, wages, bonus and benefits input output ratio indicates optimum utilisation.

Contribution to Provident and Other Funds: It is the highest ₹ 969.09 crore in 2010-11 while it is the lowest ₹ 163.00 crore in 2014-15. Its input output ratio is the lowest 0.0008 in 2014-15 as compared to the highest 0.0064 in 2010-11.

Employees Welfare Expenses and Others: It range from ₹ 326.48 crore in 2010-11 to ₹ 341.66 crore in 2017-18. Input output ratio of employee welfare expenses and others is the lowest 0.0012 in 2012-13 indicates optimum utilisation as compared to others.

Total Labour: Total labour input is ₹ 2802.85 crore in 2010-11 and reached to ₹ 2175.24 crore in 2017-18. Its input output ratio is the highest 0.0185 in 2010-11 while it is the lowest 0.0076 in 2014-15. The lowest labour input output ratio means labour input has been best utilized in the year 2014-15.

Labour Productivity Ratio: There is a fluctuating trend in the labour productivity ratio of Bharat Petroleum Corporation Ltd. It is the lowest 53.9608 in 2010-11 while it is the highest 131.9461 in 2014-15. Improvement in labour efficiency can also be observed from the average of labour indices which worked out to 164.03 which is much higher than the base year index of 100.

Testing Hypothesis and Interpretation: In Bharat Petroleum Corporation Ltd. the standard deviation calculated is 38.38 and coefficient of variation is 23.40 % indicates variability. The computed value of chi-square is 69.482 while the table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This reveals that the labour productivity indices of the company for the study period are not same and cannot be represented by straight line trend or line of best fit.

Table 5.22

Labour Productivity of Hindustan Petroleum Corporation Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	131403.70	163897.08	179216.63	182515.82	170937.91	151402.12	151501.59	177367.29
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	1246.26	1011.76	1402.58	1169.68	1242.32	1111.40	1294.88	1453.77
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0095	0.0062	0.0078	0.0064	0.0073	0.0073	0.0085	0.0082
4	Contribution to Provident and Other Funds (₹ in Crore)	75.91	71.00	112.58	89.29	82.66	82.25	84.56	89.77
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0006	0.0004	0.0006	0.0005	0.0005	0.0005	0.0006	0.0005
6	Employees Welfare Expenses and Others (₹ in Crore)	659.67	378.45	598.74	290.15	406.34	377.91	541.40	268.77
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0050	0.0023	0.0033	0.0016	0.0024	0.0025	0.0036	0.0015
8	Total Labour Input (₹ in Crore)	1981.84	1461.20	2113.89	1549.12	1731.31	1571.57	1920.84	1812.30
9	Total Labour (Input Output Ratio)	0.0151	0.0089	0.0118	0.0085	0.0101	0.0104	0.0127	0.0102
10	Labour Productivity Ratio	66.3039	112.1660	84.7803	117.8191	98.7332	96.3384	78.8724	97.8685
11	Labour Productivity Indices / Observed Indices (O)	100.00	169.17	127.87	177.70	148.91	145.30	118.96	147.61
12	Computed Value/ Expected Values (E)	137.53	138.79	140.05	141.31	142.57	143.82	145.08	146.34
13	Chi-Square $(O-E)^2/E$	10.2434	6.6486	1.0600	9.3697	0.2822	0.0151	4.7051	0.0109

Average Labour Productivity Indices=141.94, a= 141.94, b= 0.63, χ^2 = 32.335, S.D. = 23.97, C.V. = 16.89 %.

Analysis and Interpretation

Output: The revalued output of Hindustan Petroleum Corporation Ltd. is ₹ 131403.70 crore in 2010-11 and reached to ₹ 177367.29 crore in 2017-18.

Salary, Wages, Bonus and Benefits: It is the highest ₹ 1453.77 crore in 2017-18 and the lowest ₹ 1011.76 crore in 2011-12. Its input output ratio is the highest 0.0095 in 2010-11 while it is the lowest 0.0062 in 2011-12.

Contribution to Provident and Other Funds: It is the highest ₹ 112.58 crore in 2012-13 while it is the lowest ₹ 71.00 crore in 2011-12. Input output ratio of contribution to provident and other funds is the lowest 0.0004 in 2011-12 while it is the highest 0.0006 in 2010-11, 2012-13 and 2016-17.

Employees Welfare Expenses and Others: It is the lowest ₹ 268.77 crore in 2017-18 as compared to the highest ₹ 659.67 crore in 2010-11. Input output ratio is 0.0050 in 2010-11, 0.0023 in 2011-12, 0.0033 in 2012-13, 0.0016 in 2013-14, 0.0024 in 2014-15, 0.0025 in 2015-16, 0.0036 in 2016-17 and 0.0015 in 2017-18. It is the lowest 0.0015 in 2017-18 indicating that less has been expended on employees welfare and others.

Total Labour: Total labour input consumption of Hindustan Petroleum Corporation Ltd. is ₹ 1981.84 crore in 2010-11 and ultimately reached to ₹ 1812.30 crore in 2017-18. Total labour input output ratio is the highest 0.0151 in 2010-11 while it is the lowest 0.0085 in 2013-14.

Labour Productivity Ratio: Labour productivity ratio is the lowest 66.3039 in 2010-11 while it is the highest 112.1660 in 2015-16. The highest ratio displays efficiency and effectiveness in utilisation of labour input. Labour efficiency can also be observed from the average of labour indices which worked out to 141.94 as compared to the base year index of 100. This indicates that labour has been able to utilize efficiently as compared to the base year.

Testing Hypothesis and Interpretation: Standard deviation of Hindustan Petroleum Corporation Ltd. is 23.97 while its coefficient of variation is 16.89 %. The computed value of chi-square is 32.335. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This reveals that the labour productivity indices of the company for the study period are not same and cannot be represented by straight line trend or line of best fit.

Table 5.23

Labour Productivity of Indian Oil Corporation Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	326553.94	399196.39	382590.88	387987.09	362608.32	298354.22	287130.68	343394.88
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	3916.26	3289.91	3629.58	3858.21	3542.07	3559.49	4349.34	4803.49
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0120	0.0082	0.0095	0.0099	0.0098	0.0119	0.0151	0.0140
4	Contribution to Provident and Other Funds (₹ in Crore)	1625.57	660.18	1547.68	699.64	879.05	1202.33	1410.20	961.49
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0050	0.0017	0.0040	0.0018	0.0024	0.0040	0.0049	0.0028
6	Employees Welfare Expenses and Others (₹ in Crore)	893.72	646.50	908.80	492.42	673.00	423.76	577.19	625.36
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0027	0.0016	0.0024	0.0013	0.0019	0.0014	0.0020	0.0018
8	Total Labour Input (₹ in Crore)	6435.55	4596.60	6086.05	5050.27	5094.13	5185.58	6336.74	6390.35
9	Total Labour (Input Output Ratio)	0.0197	0.0115	0.0159	0.0130	0.0140	0.0174	0.0221	0.0186
10	Labour Productivity Ratio	50.7422	86.8461	62.8635	76.8250	71.1816	57.5353	45.3121	53.7365
11	Labour Productivity Indices / Observed Indices (O)	100.00	171.15	123.89	151.40	140.28	113.39	89.30	105.90
12	Computed Value/ Expected Values (E)	141.52	136.63	131.75	126.86	121.97	117.08	112.19	107.31
13	Chi-Square $(O-E)^2/E$	12.1821	8.7204	0.4686	4.7490	2.7490	0.1166	4.6723	0.0184

Average Labour Productivity Indices=124.41, a=124.41, b= - 2.44, χ^2 = 33.676, S.D.= 26.12, C.V. = 20.99 %.

Analysis and Interpretation

Output: The output is changing inconsistently. It is ₹ 326553.94 crore in 2010-11, ₹ 399196.39 crore in 2011-12, ₹ 382590.88 crore in 2012-13, ₹ 387987.09 crore in 2013-14, ₹ 362608.32 in 2014-15, ₹ 298354.22 crore in 2015-16, ₹ 287130.68 crore in 2016-17 and ₹ 343394.88 crore in 2017-18.

Salary, Wages, Bonus and Benefits: It is ₹ 3916.26 crore in 2010-11 and reached to ₹ 4803.49 crore in 2017-18. Its input output ratio is the highest 0.0151 in 2016-17 while it is the lowest 0.0082 in 2011-12. The lowest salary, wages, bonus and benefits input output ratio indicates optimum labour utilisation has been achieved in this year.

Contribution to Provident and Other Funds: Contribution to provident and other funds consumption is the highest ₹ 1625.57 crore in 2010-11 while it is the lowest ₹ 660.18 crore in 2011-12. Its input output ratio is the lowest 0.0017 in 2011-12 as compared to the highest 0.0050 in 2010-11.

Employees Welfare Expenses and Others: It is the highest ₹ 908.50 crore in 2012-13 while it is the lowest ₹ 423.76 crore in 2015-16. Its input output ratio is the lowest 0.0013 in 2013-14 while it is the highest 0.0027 in 2010-11.

Total Labour: Total labour input of Indian Oil Corporation Ltd. range between ₹ 4596.60 crore to ₹ 6435.55 crore. It is the lowest in 2010-11 and the highest in 2010-11. Total labour input output ratio is the highest 0.0221 in 2016-17 while it is the lowest 0.0115 in 2011-12. The lowest labour input output ratio means

labour has been optimally utilized in the year 2011-12 indicating that there is neither over labour in the organisation nor the labour is remained idle.

Labour Productivity Ratio: Labour productivity ratio of Indian Oil Corporation Ltd. lies between the lowest 45.3121 in 2016-17 and the highest 86.8461 in 2011-12. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the labour input has not been utilized efficiently. Improvement in labour efficiency can also be observed from the average of labour indices which is 124.41 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Indian Oil Corporation Ltd. is 26.12 with 20.99 % of variability. The computed value of chi-square is 33.676 as compared to the table value 14.067 at 5% level of significance with (8-1) = 7 degree of freedom. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This reveals that the labour productivity indices of the Indian Oil Corporation Ltd. for the study period are not same and cannot be represented by straight line trend or line of best fit.

Table 5.24

Labour Productivity of Reliance Industries Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	247978.66	307735.63	313516.10	325963.44	273830.44	204990.51	202371.59	235728.97
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	2179.21	2245.66	2448.23	2195.15	2240.63	2532.67	2535.63	2571.50
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0088	0.0073	0.0078	0.0067	0.0082	0.0124	0.0125	0.0109
4	Contribution to Provident and Other Funds (₹ in Crore)	243.31	198.45	182.47	177.78	212.95	153.45	149.31	155.96
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0010	0.0006	0.0006	0.0005	0.0008	0.0007	0.0007	0.0007
6	Employees Welfare Expenses and Others (₹ in Crore)	201.65	197.52	176.61	198.38	189.29	206.42	206.03	277.69
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0008	0.0006	0.0006	0.0006	0.0007	0.0010	0.0010	0.0012
8	Total Labour Input (₹ in Crore)	2624.17	2641.63	2807.30	2571.31	2642.86	2892.54	2890.97	3005.16
9	Total Labour (Input Output Ratio)	0.0106	0.0086	0.0090	0.0079	0.0097	0.0141	0.0143	0.0127
10	Labour Productivity Ratio	94.4979	116.4948	111.6790	126.7694	103.6113	70.8687	70.0013	78.4414
11	Labour Productivity Indices / Observed Indices (O)	100.00	123.28	118.18	134.15	109.64	74.99	74.08	83.01
12	Computed Value/ Expected Values (E)	123.79	117.61	111.43	105.26	99.08	92.90	86.72	80.54
13	Chi-Square $(O-E)^2/E$	4.5727	0.2728	0.4085	7.9319	1.1269	3.4505	1.8432	0.0756

Average Labour Productivity Indices=102.17, a =102.17, b = -3.09, χ^2 =19.682, S.D. = 21.45, C.V. = 20.99%.

Analysis and Interpretation

Output: The revalued output of Reliance Industries Ltd. is the highest ₹ 325963.44 crore in 2013-14 while it is the lowest ₹ 202371.59 crore in 2016-17.

Salary, Wages, Bonus and Benefits: It is the highest ₹ 2571.50 crore in 2017-18 and the lowest ₹ 2179.21 crore in 2010-11. Its input output ratio is 0.0088 in 2010-11, 0.0073 in 2011-12, 0.0078 in 2012-13, 0.0067 in 2013-14, 0.0082 in

2014-15, 0.0124 in 2015-16, 0.0125 in 2016-17 and 0.0109 in 2017-18. It is the highest 0.0125 in 2016-17 while it is the lowest 0.0067 in 2013-14.

Contribution to Provident and Other Funds: Its consumption is the highest ₹ 243.31 crore in 2010-11 while it is the lowest ₹ 149.31 crore in 2016-17. Input output ratio of contribution to provident and other funds is the lowest 0.0005 in 2013-14 as compared to the highest 0.0010 in 2010-11.

Employees Welfare Expenses and Others: It is the lowest ₹ 176.61 crore in 2012-13 as compared to ₹ 277.69 crore in 2017-18. Its input output ratio is the lowest 0.0006 in 2011-12, 2012-13 and 2013-14 indicates less has been expended on employees welfare and others. It is the highest 0.0012 in 2017-18.

Total Labour: Total labour input consumption of Reliance Industries Ltd. is ₹ 2624.17 crore in 2010-11 then it increased and reached to ₹ 2807.30 crore in 2012-13 then it showed a decrease and reached to ₹ 2571.31 crore in 2013-14 then it slightly increased and reached to ₹ 2892.54 crore in 2015-16 then it slightly decreased and ultimately increased and reached to ₹ 3005.16 crore in 2017-18. Total labour input output ratio is the highest 0.0143 in 2016-17 while it is the lowest 0.0079 in 2013-14.

Labour Productivity Ratio: Labour productivity ratio of Reliance Industries Ltd. is 94.4979 in 2010-11, 116.4948 in 2011-12, 111.6790 in 2012-13, 126.7694 in 2013-14, 103.6113 in 2014-15, 70.8687 in 2015-16, 70.0013 in 2016-17 and 78.4414 in 2017-18. Labour productivity ratio is the lowest 70.0013 in 2016-17 while it is the highest 126.7694 in 2013-14. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the labour input has not been utilized efficiently as compared to other years. Labour efficiency can also be analysed from the average of labour indices. It is 102.17 which is higher than the base year index of 100. This indicates that on an average labour is utilized efficiently in all the years.

Testing Hypothesis and Interpretation: The standard deviation of Reliance Industries Ltd. is 21.45 with coefficient of variation 20.99 %. The computed value of chi-square is 19.682. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected and

alternative hypothesis is accepted. This displays that the labour productivity indices of the Reliance Industries Ltd. for the study period are not same and cannot be represented by straight line trend or line of best fit.

5.6. Labour Productivity Ratios and Kruskal Wallis One Way Analysis of Variance Test

For testing the second hypothesis to compare the inter-company relationship, kruskal wallis one way analysis of variance test is applied here. In this, the labour productivity of all the sample companies is combined and arranged in order of increasing size and given a rank number. The rank sum of each of the sample has been calculated. The detailed calculation has been done in the following tables from 5.25 to 5.30.

Table 5.25

Comparative Labour Productivity Ratios from 2010-11 to 2017-18 of Automobile Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	Bajaj Auto Ltd.		Mahindra & Mahindra Ltd.		Maruti Suzuki India Ltd.		Tata Motors Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	34.2233	23	16.5504	4	52.6879	32	20.5566	12
2011-12	36.9079	28	18.5395	7	42.7662	31	20.0497	10
2012-13	33.4079	22	22.4960	16	42.6247	30	16.8974	5
2013-14	30.6703	19	20.2413	11	34.8191	24	14.3055	2
2014-15	27.7330	17	19.2216	8	35.2270	25	13.5647	1
2015-16	31.7614	21	21.8545	14	36.0846	26	18.1338	6
2016-17	29.0478	18	21.1384	13	37.8815	29	15.1046	3
2017-18	31.2639	20	22.1437	15	36.4000	27	19.4535	9
Total		168		88		224		48

H = 26.636

Hypothesis Testing and Interpretation: The calculated value of H is 26.636 at 5% level of significance with 4 - 1 = 3 degrees of freedom and the table value is 7.815. As the calculated value is greater than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that the labour productivity ratios of the automobile sector companies included in Nifty 50 are not same indicates the significance difference in the labour productivity ratios.

Table 5.26

Comparative Labour Productivity Ratios from 2010-11 to 2017-18 of Energy Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	GAIL (India) Ltd.		NTPC Ltd.		Oil and Natural Gas Corporation Ltd.		Power Grid Corporation of India Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	45.5399	25	20.5782	14	10.6615	5	12.1985	9
2011-12	66.0328	30	20.8639	16	11.8361	7	12.7248	10
2012-13	63.0185	28	21.0062	17	8.7843	1	15.4322	11
2013-14	72.8924	32	20.6560	15	9.3232	2	17.8547	12
2014-15	71.7277	31	23.3901	20	11.4720	6	19.5253	13
2015-16	65.8182	29	24.4864	23	11.9273	8	26.7538	24
2016-17	49.5535	26	23.1585	19	9.3381	3	24.3601	22
2017-18	52.8852	27	22.6803	18	10.2787	4	24.1444	21
Total		228		142		36		122

H = 26.466

Hypothesis Testing and Interpretation: The calculated value of H is 26.466 at 5 % level of significance with 4 - 1 = 3 degrees of freedom and the table value is 7.815. As the calculated value is greater than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that the labour productivity ratios of the energy sector companies are not same results in the significant difference in labour productivity ratios.

Table 5.27

Comparative Labour Productivity Ratios from 2010-11 to 2017-18 of Information Technology Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	Infosys Ltd.		Tata Consultancy Services Ltd.		Tech Mahindra Ltd.		Wipro Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	2.1295	3	2.9215	23	2.6197	19	2.4640	11
2011-12	2.1576	4	2.9303	24	2.3465	7	2.4623	10
2012-13	2.0113	1	3.0435	26	2.4115	9	2.2284	5
2013-14	2.0606	2	3.3772	28	2.5105	14	2.3544	8
2014-15	2.2665	6	3.2056	27	3.0108	25	2.4763	12
2015-16	2.4907	13	3.6735	30	3.6728	29	2.7331	20
2016-17	2.5434	16	2.5515	17	3.9213	31	2.8219	22
2017-18	2.5599	18	2.5245	15	3.9475	32	2.7369	21
Total		63		190		166		109

H = 13.935

Hypothesis Testing and Interpretation: The calculated value of H is 13.935 at 5% level of significance with 4 - 1 = 3 degrees of freedom and the table value is 7.815. As the calculated value is greater than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that the labour productivity ratios of the information technology sector companies included in Nifty 50 are not same.

Table 5.28

Comparative Labour Productivity Ratios from 2010-11 to 2017-18 of Metals Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	Coal India Ltd.		Hindalco Ltd.		Tata Steel Ltd.		Vedanta Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	21.7969	10	22.8876	12	10.4851	2	53.6366	26
2011-12	30.6853	20	23.9458	14	11.2927	4	36.0985	22
2012-13	33.8666	21	23.2196	13	11.0247	3	13.8075	7
2013-14	49.3431	25	22.4834	11	12.3288	6	56.9981	28
2014-15	44.5024	23	25.0890	16	10.1745	1	60.1290	29
2015-16	55.8895	27	25.8258	17	12.0405	5	79.1786	32
2016-17	46.7034	24	26.5416	18	14.3480	8	73.9829	30
2017-18	23.9493	15	28.8193	19	16.1362	9	77.5935	31
Total		165		120		38		205

H = 21.872

Hypothesis Testing and Interpretation: The calculated value of H is 21.872 and the table value is 7.815 at 5 % level of significance with 4 - 1 = 3 degrees of freedom. As the calculated value is more than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that there is a significant difference in the labour productivity ratios of the metals sector companies.

Table 5.29

Comparative Labour Productivity Ratios from 2010-11 to 2017-18 of Pharmaceutical Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

Year	Cipla Ltd.		Dr. Reddy's Laboratories Ltd.		Lupin Ltd.		Sun Pharmaceutical Industries Ltd.	
	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	13.5893	31	7.6228	9	9.1830	21	15.4173	32
2011-12	9.7477	22	7.7131	12	8.9937	19	13.4367	30
2012-13	8.6196	16	7.6424	10	10.0219	23	11.6134	27
2013-14	7.9101	13	8.7630	18	11.7527	29	11.3729	25
2014-15	7.4146	7	7.6944	11	10.4262	24	6.4626	1
2015-16	8.6247	17	7.5142	8	11.6917	28	6.6424	3
2016-17	8.1481	14	7.2188	6	11.3866	26	6.8508	4
2017-18	8.1627	15	6.5041	2	9.0075	20	7.1944	5
Total		135		76		190		127

H= 9.281

Testing Hypothesis and Interpretation: The calculated value of H is 9.281 and the table value is 7.815 at 5 % level of significance with 4 - 1 = 3 degrees of freedom. As the calculated value is more than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that the labour productivity ratios of the pharmaceutical sector companies included in Nifty 50 are not same that is there is a significant difference in labour productivity.

Table 5.30

Comparative Labour Productivity Ratios from 2010-11 to 2017-18 of Refineries Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

Year	Bharat Petroleum Corporation Ltd.		Hindustan Petroleum Corporation Ltd.		Indian Oil Corporation Ltd.		Reliance Industries Ltd.	
	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	53.9608	4	66.3039	7	50.7422	2	94.4979	21
2011-12	93.7251	20	112.1660	28	86.8461	17	116.4948	29
2012-13	89.0764	19	84.7803	16	62.8635	6	111.6790	27
2013-14	95.8187	22	117.8191	30	76.8250	12	126.7694	31
2014-15	131.9461	32	98.7332	25	71.1816	10	103.6113	26
2015-16	82.2239	15	96.3384	23	57.5353	5	70.8687	9
2016-17	73.3313	11	78.8724	14	45.3121	1	70.0013	8
2017-18	88.0252	18	97.8685	24	53.7365	3	78.4414	13
Total		141		167		56		164

H = 11.514

Testing Hypothesis and Interpretation: The calculated value of H is 11.514 and the table value is 7.815 at 5 % level of significance with 4 - 1 = 3 degrees of freedom. As the calculated value is more than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that the labour productivity ratios of the refineries sector companies are not same indicates significant difference in labour productivity.

5.7. Possible Savings

Possible savings in labour input has been calculated to analyse what would have been saved if the labour input has best utilized. Possible savings in labour input for all six sectors are being discussed here under.

5.7.1. Possible Savings in Labour Input of Automobile Sector Companies

Possible savings in total labour input along with its three components viz., salary, wages, bonus and benefits, contribution to provident and other funds and employees welfare expenses and others of automobile sector has been calculated here.

Table 5.31

Possible Savings in Labour Input of Automobile Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bajaj Auto Ltd.	Mahindra & Mahindra Ltd.	Maruti Suzuki India Ltd.	Tata Motors Ltd.
2010-11	Standard	458	1054	704	2294
	Actual	494	1432	704	2294
	Saving	**36**	**378**	**0**	**0**
2011-12	Standard	499	1296	633	2421
	Actual	499	1571	779	2484
	Saving	**0**	**275**	**146**	**63**
2012-13	Standard	485	1562	725	1950
	Actual	535	1562	895	2375
	Saving	**50**	**0**	**170**	**425**
2013-14	Standard	461	1487	691	1527
	Actual	554	1651	1044	2196
	Saving	**93**	**164**	**353**	**669**
2014-15	Standard	484	1421	771	1461
	Actual	643	1661	1152	2217
	Saving	**159**	**240**	**381**	**756**
2015-16	Standard	537	1547	926	1811
	Actual	624	1590	1350	2055
	Saving	**87**	**43**	**424**	**244**
2016-17	Standard	512	1665	1094	1802
	Actual	650	1770	1520	2454
	Saving	**138**	**105**	**426**	**652**
2017-18	Standard	574	1775	1243	2378
	Actual	678	1801	1797	2515
	Saving	**104**	**26**	**554**	**137**
Total Savings		669	1232	2455	2947

Note: Amount has been rounded off to nearest ₹

Table 5.31 depicts that the total possible savings in labour input of Bajaj Auto Ltd. would have been ₹ 669 crore, Mahindra & Mahindra Ltd. ₹ 1232 crore, Maruti Suzuki India Ltd. ₹ 2455 crore and lastly Tata Motors Ltd. ₹ 2947 crore. For calculating possible savings year of the lowest labour input output ratio has been taken as the base year. The year 2011-12 has been regarded as the base year for Bajaj Auto Ltd. For Mahindra and Mahindra Ltd. base year is 2012-13. For Maruti Suzuki India Ltd. and Tata Motors Ltd. base year is 2010-11.

1. **Possible Savings in Salary, Wages, Bonus and Benefits**

Possible savings in salary, wages, bonus and benefits of automobile sector companies included in Nifty 50 from 2010-11 to 2017-18 has been shown in the table 5.32.

Table 5.32

Possible Savings in Salary, Wages, Bonus and Benefits of Automobile Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bajaj Auto Ltd.	Mahindra & Mahindra Ltd.	Maruti Suzuki India Ltd.	Tata Motors Ltd.
2010-11	Standard	380	860	626	1842
	Actual	389	1157	626	1842
	Saving	**9**	**297**	**0**	**0**
2011-12	Standard	414	1057	563	1947
	Actual	414	1224	702	2025
	Saving	**0**	**167**	**139**	**78**
2012-13	Standard	402	1276	645	1569
	Actual	436	1276	766	1935
	Saving	**34**	**0**	**121**	**366**
2013-14	Standard	383	1213	614	1228
	Actual	465	1335	923	1797
	Saving	**82**	**122**	**309**	**569**
2014-15	Standard	401	1159	686	1176
	Actual	507	1351	1013	1810
	Saving	**106**	**192**	**327**	**634**
2015-16	Standard	446	1262	823	1457
	Actual	537	1283	1181	1731
	Saving	**91**	**21**	**358**	**274**
2016-17	Standard	425	1358	973	1450
	Actual	563	1428	1354	2073
	Saving	**138**	**70**	**381**	**623**
2017-18	Standard	477	1448	1105	1913
	Actual	588	1471	1581	2100
	Saving	**111**	**23**	**476**	**187**
Total Savings		571	893	2110	2731

Note: Amount has been rounded off to nearest ₹

Table 5.32 demonstrates that total possible savings in salary, wages, bonus and benefits for a period of eight years would have been ₹ 571 crore of Bajaj Auto Ltd., ₹ 893 crore of Mahindra & Mahindra Ltd., ₹ 2110 crore of Maruti Suzuki India Ltd. and lastly ₹ 2731 crore of Tata Motors Ltd.

2. Possible Savings in Contribution to Provident and Other Funds

An attempt has been made to calculate the possible savings in contribution to provident and other funds of labour input.

Table 5.33

Possible Savings in Contribution to Provident and Other Funds of Automobile Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bajaj Auto Ltd.	Mahindra & Mahindra Ltd.	Maruti Suzuki India Ltd.	Tata Motors Ltd.
2010-11	Standard	41	69	30	146
	Actual	61	135	30	219
	Saving	**20**	**66**	**0**	**73**
2011-12	Standard	44	84	27	154
	Actual	46	132	30	194
	Saving	**2**	**48**	**3**	**40**
2012-13	Standard	43	103	31	124
	Actual	58	103	56	174
	Saving	**15**	**0**	**25**	**50**
2013-14	Standard	41	97	29	97
	Actual	49	136	53	167
	Saving	**8**	**39**	**24**	**70**
2014-15	Standard	43	93	32	93
	Actual	94	153	65	162
	Saving	**51**	**60**	**33**	**69**
2015-16	Standard	47	101	39	117
	Actual	47	117	67	117
	Saving	**0**	**16**	**28**	**0**
2016-17	Standard	45	108	46	115
	Actual	45	127	62	136
	Saving	**0**	**19**	**16**	**21**
2017-18	Standard	51	116	52	150
	Actual	51	132	83	150
	Saving	**0**	**16**	**31**	**0**
Total Savings		97	264	160	322

Note: Amount has been rounded off to nearest ₹

Table 5.33 reveals that total possible savings in contribution to provident fund and other funds for the period of eight years of Bajaj Auto Ltd. might have been ₹ 97 crore., Mahindra & Mahindra Ltd. ₹ 264 crore, Maruti Suzuki India Ltd. ₹ 160 crore and lastly ₹ 322 crore of Tata Motors Ltd.

3. Possible Savings in Employees Welfare Expenses and Others

Table 5.34 shows the possible savings would have been in Employees Welfare expenses and others if its standard has to be maintained.

Table 5.34

Possible Savings in Employees Welfare Expenses and Others of Automobile Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bajaj Auto Ltd.	Mahindra & Mahindra Ltd.	Maruti Suzuki India Ltd.	Tata Motors Ltd.
2010-11	Standard	30	116	48	233
	Actual	43	140	48	233
	Saving	**13**	**24**	**0**	**0**
2011-12	Standard	33	143	43	244
	Actual	39	214	46	265
	Saving	**6**	**71**	**3**	**21**
2012-13	Standard	32	172	50	197
	Actual	42	184	73	266
	Saving	**10**	**12**	**23**	**69**
2013-14	Standard	31	164	47	154
	Actual	40	180	69	231
	Saving	**9**	**16**	**22**	**77**
2014-15	Standard	32	158	53	147
	Actual	42	158	74	245
	Saving	**10**	**0**	**21**	**98**
2015-16	Standard	36	170	63	183
	Actual	40	191	103	208
	Saving	**4**	**21**	**40**	**25**
2016-17	Standard	34	183	75	182
	Actual	42	215	103	245
	Saving	**8**	**32**	**28**	**63**
2017-18	Standard	39	195	85	240
	Actual	39	199	132	266
	Saving	**0**	**4**	**47**	**26**
Total Savings		60	179	184	380

Note: Amount has been rounded off to nearest ₹

Table 5.34 portrays that ₹ 380 crore would be possible saving of Tata Motors Ltd. if its input is properly utilized. Maruti Suzuki India Ltd. would have saved ₹ 184 crore, Mahindra & Mahindra Ltd. would have saved ₹ 179 crore and lastly Bajaj Auto Ltd. would have saved ₹ 60 crore in totality in the study period.

Optimum utilisation of labour input can also be possible if trained and experienced labour is employed in the organisation as compared to the untrained and unskilled labour. Labour efficiency can also be improved by giving incentive to them on their performance.

5.7.2. Possible Savings in Labour Input of Energy Sector Companies

Possible savings in labour input including its parts such as salary, wages, bonus and benefits, contribution to provident and other funds and employees welfare expenses and others of energy sector companies has been elaborated below:

Table 5.35

Possible Savings in Labour Input of Energy Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		GAIL (India) Ltd.	NTPC Ltd.	Oil and Natural Gas Corporation Ltd.	Power Grid Corporation of India Ltd.
2010-11	Standard	450	2342	6011	340
	Actual	721	2790	6728	746
	Saving	**271**	**448**	**717**	**406**
2011-12	Standard	507	2428	6222	370
	Actual	561	2853	6273	778
	Saving	**54**	**425**	**51**	**408**
2012-13	Standard	568	2410	6365	428
	Actual	657	2812	8646	742
	Saving	**89**	**402**	**2281**	**314**
2013-14	Standard	647	2487	6203	480
	Actual	647	2951	7939	719
	Saving	**0**	**464**	**1736**	**239**
2014-15	Standard	639	2477	5949	536
	Actual	650	2596	6188	734
	Saving	**11**	**119**	**239**	**198**
2015-16	Standard	610	2451	5935	666
	Actual	676	2451	5935	666
	Saving	**66**	**0**	**0**	**0**
2016-17	Standard	557	2664	5893	818
	Actual	820	2820	7531	898
	Saving	**263**	**156**	**1638**	**80**
2017-18	Standard	598	2778	6215	919
	Actual	825	3002	7216	1018
	Saving	**227**	**224**	**1001**	**99**
Total Savings		982	2237	7664	1743

Note: Amount has been rounded off to nearest ₹

Table 5.35 manifests that the total possible savings in labour input for a period of eight years would have been ₹ 982 crore of GAIL (India) Ltd., ₹ 2237 crore of NTPC Ltd., ₹ 7664 crore of Oil and Natural Gas Corporation Ltd and ₹ 1743 crore of Power Grid Corporation of India Ltd. Possible savings have been calculated by multiplying the minimum input output ratio with the output of the respective year.

1. Possible Savings in Salary, Wages, Bonus and Benefits of Energy Sector Companies

It is regarded as very important and essential aspect of labour input. For analyzing this possible savings has been calculated and results has been analysed.

Table 5.36

Possible Savings in Salary, Wages, Bonus and Benefits of Energy Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		GAIL (India) Ltd.	NTPC Ltd.	Oil and Natural Gas Corporation Ltd.	Power Grid Corporation of India Ltd.
2010-11	Standard	319	1607	4440	227
	Actual	546	2158	5020	511
	Saving	**227**	**551**	**580**	**284**
2011-12	Standard	359	1666	4596	247
	Actual	372	2307	4768	616
	Saving	**13**	**641**	**172**	**369**
2012-13	Standard	402	1654	4701	285
	Actual	446	2204	5706	540
	Saving	**44**	**550**	**1005**	**255**
2013-14	Standard	458	1707	4582	319
	Actual	458	1850	4902	508
	Saving	**0**	**143**	**320**	**189**
2014-15	Standard	450	1700	4394	357
	Actual	450	1809	4894	437
	Saving	**0**	**109**	**500**	**80**
2015-16	Standard	432	1680	4385	443
	Actual	481	1712	4385	443
	Saving	**49**	**32**	**0**	**0**
2016-17	Standard	394	1829	4353	545
	Actual	494	1829	4851	560
	Saving	**100**	**0**	**498**	**15**
2017-18	Standard	423	1906	4591	612
	Actual	626	2252	5841	825
	Saving	**203**	**346**	**1250**	**213**
Total Savings		636	2370	4325	1406

Note: Amount has been rounded off to nearest ₹

Table 5.36 displays that the total possible savings in salary, wages, bonus and benefits for the period of eight years might have been ₹ 636 crore of GAIL (India) Ltd., ₹ 2370 crore of NTPC Ltd., ₹ 4325 crore of Oil and Natural Gas Corporation Ltd. and ₹ 1406 crore of Power Grid Corporation of India Ltd.

2. Possible Savings in Contribution to Provident and Other Funds of Energy Sector Companies

Another aspect to discuss is contribution to provident and other funds. An attempt has been made to calculate the possible savings in it.

Table 5.37

Possible Savings in Contribution to Provident and Other Funds of Energy Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		GAIL (India) Ltd.	NTPC Ltd.	Oil and Natural Gas Corporation Ltd.	Power Grid Corporation of India Ltd.
2010-11	Standard	60	264	328	26
	Actual	60	338	328	149
	Saving	**0**	**74**	**0**	**123**
2011-12	Standard	67	273	342	29
	Actual	77	273	696	82
	Saving	**10**	**0**	**354**	**53**
2012-13	Standard	75	272	349	33
	Actual	110	312	373	117
	Saving	**35**	**40**	**24**	**84**
2013-14	Standard	85	280	340	37
	Actual	88	763	689	122
	Saving	**3**	**483**	**349**	**85**
2014-15	Standard	84	279	327	42
	Actual	94	373	677	192
	Saving	**10**	**94**	**350**	**150**
2015-16	Standard	80	276	326	52
	Actual	101	369	672	123
	Saving	**21**	**93**	**346**	**71**
2016-17	Standard	73	300	324	63
	Actual	220	703	660	233
	Saving	**147**	**403**	**336**	**170**
2017-18	Standard	77	313	341	71
	Actual	77	395	723	71
	Saving	**0**	**82**	**382**	**0**
Total Savings		227	1268	2142	736

Note: Amount has been rounded off to nearest ₹

Table 5.37 conveys that total possible savings in contribution to provident and other funds element of labour input might have been the maximum ₹ 2142 crore of Oil and Natural Gas Corporation Ltd. while the minimum ₹ 227 crore of GAIL (India) Ltd.

3. Possible Savings in Employees Welfare Expenses and Others of Energy Sector Companies

Another important factor of labour input is employees welfare expenses and others. For analyzing this possible savings has been calculated and results has been analysed.

Table 5.38

Possible Savings in Employees Welfare Expenses and Others of Energy Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		GAIL (India) Ltd.	NTPC Ltd.	Oil and Natural Gas Corporation Ltd.	Power Grid Corporation of India Ltd.
2010-11	Standard	69	253	624	44
	Actual	115	293	1380	86
	Saving	**46**	**40**	**756**	**42**
2011-12	Standard	78	262	646	48
	Actual	111	272	809	81
	Saving	**33**	**10**	**163**	**33**
2012-13	Standard	87	260	661	55
	Actual	101	297	2567	85
	Saving	**14**	**37**	**1906**	**30**
2013-14	Standard	101	268	644	62
	Actual	101	339	2349	89
	Saving	**0**	**71**	**1705**	**27**
2014-15	Standard	98	267	616	69
	Actual	106	414	616	104
	Saving	**8**	**147**	**0**	**35**
2015-16	Standard	94	264	616	85
	Actual	94	370	878	100
	Saving	**0**	**106**	**262**	**15**
2016-17	Standard	85	288	612	105
	Actual	106	288	2020	105
	Saving	**21**	**0**	**1408**	**0**
2017-18	Standard	92	300	645	118
	Actual	122	354	652	122
	Saving	**30**	**54**	**7**	**4**
Total Savings		152	466	6207	187

Note: Amount has been rounded off to nearest ₹

Table 5.38 depicts that ₹ 6207 crore would be possible saving of Oil and Natural Gas Corporation Ltd., ₹ 466 crore of NTPC Ltd., ₹ 187 crore of Power Grid Corporation of India Ltd. and ₹ 152 crore GAIL (India) Ltd.

5.7.3. Possible Savings in Labour Input of Information Technology Sector Companies

To improve the performance of information technology sector companies, possible savings in respect of labour input along with its all sections has been stated below.

Table 5.39

Possible Savings in Labour Input of Information Technology Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Infosys Ltd.	Tata Consultancy Services Ltd.	Tech Mahindra Ltd.	Wipro Ltd.
2010-11	Standard	10363	8104	1290	9551
	Actual	12459	10190	1944	10937
	Saving	**2096**	**2086**	**654**	**1386**
2011-12	Standard	12036	10381	1235	10722
	Actual	14282	13015	2078	12287
	Saving	**2246**	**2634**	**843**	**1565**
2012-13	Standard	13107	11844	1285	10513
	Actual	16683	14297	2104	13312
	Saving	**3576**	**2453**	**819**	**2799**
2013-14	Standard	14954	15057	3383	11674
	Actual	18579	16379	5319	13992
	Saving	**3625**	**1322**	**1936**	**2317**
2014-15	Standard	15942	17123	3938	12413
	Actual	18007	19623	5163	14144
	Saving	**2065**	**2500**	**1225**	**1731**
2015-16	Standard	18633	20416	4681	14061
	Actual	19152	20416	5031	14517
	Saving	**519**	**0**	**350**	**456**
2016-17	Standard	20044	21788	5015	14249
	Actual	20175	31372	5049	14249
	Saving	**131**	**9584**	**34**	**0**
2017-18	Standard	20587	22436	5140	13379
	Actual	20587	32650	5140	13793
	Saving	**0**	**10214**	**0**	**414**
Total Savings		14259	30793	5862	10669

Note: Amount has been rounded off to nearest ₹

Table 5.39 conveys that the total possible savings in labour input would have been ₹ 14259 crore of Infosys Ltd., ₹ 30793 crore of Tata Consultancy Services Ltd., ₹ 5862 crore of Tech Mahindra Ltd. and lastly ₹ 10669 crore of Wipro Ltd. For calculating possible savings year of the lowest labour input output ratio has been taken as the base year.

1. Possible Savings in Salary, Wages, Bonus and Benefits of Information Technology Sector Companies

The essential element of labour input is salary, wages, bonus and benefits. For analyzing this possible savings has been calculated and results has been analysed.

Table 5.40

Possible Savings in Salary, Wages, Bonus and Benefits of Information Technology Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Infosys Ltd.	Tata Consultancy Services Ltd.	Tech Mahindra Ltd.	Wipro Ltd.
2010-11	Standard	10093	7163	1193	9211
	Actual	11994	8884	1745	10292
	Saving	**1901**	**1721**	**552**	**1081**
2011-12	Standard	11722	9176	1142	10340
	Actual	13863	11482	1827	11686
	Saving	**2141**	**2306**	**685**	**1346**
2012-13	Standard	12764	10469	1189	10139
	Actual	16341	12611	1903	12704
	Saving	**3577**	**2142**	**714**	**2565**
2013-14	Standard	14563	13309	3129	11259
	Actual	18199	14527	4922	13392
	Saving	**3636**	**1218**	**1793**	**2133**
2014-15	Standard	15525	15135	3642	11971
	Actual	17573	17525	4685	13481
	Saving	**2048**	**2390**	**1043**	**1510**
2015-16	Standard	18146	18044	4330	13561
	Actual	18707	18044	4611	13726
	Saving	**561**	**0**	**281**	**165**
2016-17	Standard	19520	19259	4639	13744
	Actual	19632	28607	4650	13744
	Saving	**112**	**9348**	**11**	**0**
2017-18	Standard	20046	19831	4754	12903
	Actual	20046	29801	4754	13290
	Saving	**0**	**9970**	**0**	**387**
Total Savings		13975	29095	5079	9185

Note: Amount has been rounded off to nearest ₹

Table 5.40 portrays that the total possible savings in salary, wages, bonus and benefits element of labour input for a period of eight years might have been the lowest ₹ 5079 crore of Tech Mahindra Ltd. with the base year as 2017-18 and the highest ₹ 29095 crore of Tata Consultancy Services Ltd. with base year is 2015-16.

2. Possible Savings in Contribution to Provident and Other Funds of Information Technology Sector Companies

Next factor of labour input to discuss and analyse is contribution to provident and other funds. An attempt has been made to calculate the possible savings in it.

Table 5.41

Possible Savings in Contribution to Provident and Other Funds of Information Technology Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Infosys Ltd.	Tata Consultancy Services Ltd.	Tech Mahindra Ltd.	Wipro Ltd.
2010-11	Standard	207	479	82	46
	Actual	410	596	122	378
	Saving	**203**	**117**	**40**	**332**
2011-12	Standard	240	614	79	51
	Actual	374	706	158	317
	Saving	**134**	**92**	**79**	**266**
2012-13	Standard	262	701	82	50
	Actual	316	812	175	330
	Saving	**54**	**111**	**93**	**280**
2013-14	Standard	299	888	216	56
	Actual	330	888	373	308
	Saving	**31**	**0**	**157**	**252**
2014-15	Standard	318	1013	252	60
	Actual	372	1103	426	267
	Saving	**54**	**90**	**174**	**207**
2015-16	Standard	371	1207	299	67
	Actual	371	1270	382	383
	Saving	**0**	**63**	**83**	**316**
2016-17	Standard	400	1289	321	68
	Actual	417	1946	365	68
	Saving	**17**	**657**	**44**	**0**
2017-18	Standard	411	1327	329	64
	Actual	441	2007	329	90
	Saving	**30**	**680**	**0**	**26**
Total Savings		523	1810	669	1678

Note: Amount has been rounded off to nearest ₹

Table 5.41 highlighted that Infosys Ltd. can save ₹ 523 crore, Tata Consultancy Services Ltd. ₹ 1810 crore, Tech Mahindra Ltd. ₹ 669 crore and lastly Wipro Ltd. ₹ 1678 crore.

3. Possible Savings in Employees Welfare expenses and Others of Information Technology Sector Companies

Another aspect of labour input is employees welfare and others. For analyzing this possible savings has been calculated and results has been analysed.

Table 5.42

Possible Savings in Employees Welfare Expenses and Others of Information Technology Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Infosys Ltd.	Tata Consultancy Services Ltd.	Tech Mahindra Ltd.	Wipro Ltd.
2010-11	Standard	21	304	9	237
	Actual	55	710	78	267
	Saving	**34**	**406**	**69**	**30**
2011-12	Standard	25	389	8	266
	Actual	45	827	93	284
	Saving	**20**	**438**	**85**	**18**
2012-13	Standard	26	444	9	261
	Actual	26	874	27	278
	Saving	**0**	**430**	**18**	**17**
2013-14	Standard	31	564	23	291
	Actual	50	964	25	291
	Saving	**19**	**400**	**2**	**0**
2014-15	Standard	33	642	26	308
	Actual	62	996	52	395
	Saving	**29**	**354**	**26**	**87**
2015-16	Standard	38	765	31	349
	Actual	73	1102	38	408
	Saving	**35**	**337**	**7**	**59**
2016-17	Standard	41	819	35	354
	Actual	126	819	35	437
	Saving	**85**	**0**	**0**	**83**
2017-18	Standard	42	843	34	332
	Actual	101	843	56	414
	Saving	**59**	**0**	**22**	**82**
Total Savings		281	2366	228	375

Note: Amount has been rounded off to nearest ₹

Table 5.42 portrays that Infosys Ltd. would be able to save ₹ 281 crore, Tata Consultancy Services Ltd. would be able to save ₹ 2366 crore, Tech Mahindra Ltd. would be able to save ₹ 227 crore and Wipro Ltd. would be able to save ₹ 375 crore during the study period of eight years.

5.7.4. Possible Savings in Labour Input of Metals Sector Companies

Possible savings in labour input along with its components has been calculated as under:

Table 5.43

Possible Savings in Labour Input of Metals Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Coal India Ltd.	Hindalco Ltd.	Tata Steel Ltd.	Vedanta Ltd.
2010-11	Standard	98	826	1845	101
	Actual	251	1040	2837	149
	Saving	**153**	**214**	**992**	**48**
2011-12	Standard	157	854	1969	80
	Actual	285	1028	2813	177
	Saving	**128**	**174**	**844**	**97**
2012-13	Standard	176	810	2061	27
	Actual	290	1005	3015	155
	Saving	**114**	**195**	**954**	**128**
2013-14	Standard	239	801	2142	306
	Actual	271	1027	2803	427
	Saving	**32**	**226**	**661**	**121**
2014-15	Standard	209	992	2081	353
	Actual	263	1140	3300	466
	Saving	**54**	**148**	**1219**	**113**
2015-16	Standard	258	1033	2192	410
	Actual	258	1153	2937	410
	Saving	**0**	**120**	**745**	**0**
2016-17	Standard	227	1052	2671	477
	Actual	271	1142	3003	511
	Saving	**44**	**90**	**332**	**34**
2017-18	Standard	143	1201	3061	497
	Actual	333	1201	3061	508
	Saving	**190**	**0**	**0**	**11**
Total Savings		716	1166	5746	552

Note: Amount has been rounded off to nearest ₹

Table 5.43 suggests that the total possible savings in labour input for a period of eight years would have been ₹ 716 crore of Coal India Ltd., ₹ 1166 crore of Hindalco Ltd., ₹ 5746 crore of Tata Steel Ltd. and lastly ₹ 552 crore of Vedanta Ltd. For calculating the possible savings year of the lowest labour input output ratio has been taken as the base year. The year 2015-16 has been regarded as the base year for Coal India Ltd. and Vedanta Ltd. while for Hindalco Ltd. and Tata Steel Ltd. base year is 2017-18.

1. Possible Savings in Salary, Wages, Bonus and Benefits of Metals Sector Companies

This is the most important aspect of labour input. For analyzing it, possible savings has been calculated and results has been analysed.

Table 5.44

Possible Savings in Salary, Wages, Bonus and Benefits of Metals Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Coal India Ltd.	Hindalco Ltd.	Tata Steel Ltd.	Vedanta Ltd.
2010-11	Standard	66	676	1577	74
	Actual	181	789	2107	122
	Saving	**115**	**113**	**530**	**48**
2011-12	Standard	106	699	1683	59
	Actual	193	822	2442	144
	Saving	**87**	**123**	**759**	**85**
2012-13	Standard	119	663	1762	20
	Actual	194	813	2441	129
	Saving	**75**	**150**	**679**	**109**
2013-14	Standard	162	656	1831	226
	Actual	194	819	2465	373
	Saving	**32**	**163**	**634**	**147**
2014-15	Standard	142	812	1779	261
	Actual	181	874	2559	412
	Saving	**39**	**62**	**780**	**151**
2015-16	Standard	174	846	1874	302
	Actual	174	930	2450	362
	Saving	**0**	**84**	**576**	**60**
2016-17	Standard	153	861	2283	352
	Actual	166	939	2565	370
	Saving	**13**	**78**	**282**	**18**
2017-18	Standard	96	983	2619	366
	Actual	169	983	2619	366
	Saving	**73**	**0**	**0**	**0**
Total Savings		434	773	4239	618

Note: Amount has been rounded off to nearest ₹

Table 5.44 reveals that the total possible savings in salary, wages, bonus and benefits of metals sector companies. It might be the highest ₹ 4239 crore of Tata Steel Ltd. while it might be the lowest ₹ 434 crore of Coal India Ltd. The year 2015-16 has been regarded as the base year for Coal India Ltd. while 2017-18 has been considered as a base year for Hindalco Ltd., Tata Steel Ltd. and Vedanta Ltd.

2. Possible Savings in Contribution to Provident and Other Funds of Metals Sector Companies

An attempt has been made to calculate the possible savings in contribution to provident and other funds of metals sector companies.

Table 5.45

Possible Savings in Contribution to Provident and Other Funds of Metals Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Coal India Ltd.	Hindalco Ltd.	Tata Steel Ltd.	Vedanta Ltd.
2010-11	Standard	7	76	170	4
	Actual	18	147	492	14
	Saving	**11**	**71**	**322**	**10**
2011-12	Standard	11	79	181	3
	Actual	19	111	276	16
	Saving	**8**	**32**	**95**	**13**
2012-13	Standard	13	75	189	1
	Actual	22	99	351	14
	Saving	**9**	**24**	**162**	**13**
2013-14	Standard	17	74	197	12
	Actual	20	115	279	26
	Saving	**3**	**41**	**82**	**14**
2014-15	Standard	15	91	191	14
	Actual	19	163	430	24
	Saving	**4**	**72**	**239**	**10**
2015-16	Standard	19	95	202	18
	Actual	19	119	315	18
	Saving	**0**	**24**	**113**	**0**
2016-17	Standard	16	98	246	19
	Actual	18	98	283	52
	Saving	**2**	**0**	**37**	**33**
2017-18	Standard	10	111	283	20
	Actual	18	113	283	54
	Saving	**8**	**2**	**0**	**34**
Total Savings		44	266	1050	127

Note: Amount has been rounded off to nearest ₹

Table 5.45 conveys that total possible savings in contribution to provident and other funds for a period of eight years of Coal India Ltd. would have been ₹ 44 crore, Hindalco Ltd. ₹ 266 crore, Tata Steel Ltd. ₹ 1050 crore and lastly Vedanta Ltd. ₹ 127 crore.

3. Possible Savings in Employees Welfare Expenses and Others of Metals Sector Companies

Another part of labour input is employees welfare expenses and others. For analyzing this possible savings has been calculated and results has been analysed.

Table 5.46

Possible Savings in Employees Welfare Expenses and Others of Metals Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Coal India Ltd.	Hindalco Ltd.	Tata Steel Ltd.	Vedanta Ltd.
2010-11	Standard	24	71	51	7
	Actual	52	105	239	14
	Saving	**28**	**34**	**188**	**7**
2011-12	Standard	38	74	54	6
	Actual	74	95	94	17
	Saving	**36**	**21**	**40**	**11**
2012-13	Standard	42	70	57	2
	Actual	75	93	223	11
	Saving	**33**	**23**	**166**	**9**
2013-14	Standard	57	69	58	22
	Actual	57	93	58	28
	Saving	**0**	**24**	**0**	**6**
2014-15	Standard	50	86	57	25
	Actual	63	102	310	30
	Saving	**13**	**16**	**253**	**5**
2015-16	Standard	62	89	60	30
	Actual	65	104	171	30
	Saving	**3**	**15**	**111**	**0**
2016-17	Standard	54	91	73	34
	Actual	87	105	154	89
	Saving	**33**	**14**	**81**	**55**
2017-18	Standard	34	105	84	36
	Actual	146	105	159	89
	Saving	**112**	**0**	**75**	**53**
Total Savings		257	146	915	146

Note: Amount has been rounded off to nearest ₹

Table 5.46 highlights that ₹ 915 crore would be possible saving of Tata Steel Ltd. which is the highest among the others while ₹ 146 crore would be the lowest possible savings reported by Hindalco Ltd. and Vedanta Ltd.

5.7.5. Possible Savings in Labour Input of Pharmaceutical Sector Companies

Below tables highlights the possible savings in labour input of pharmaceutical sector companies including its parts.

Table 5.47

Possible Savings in Labour Input of Pharmaceutical Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Cipla Ltd.	Dr. Reddy's Laboratories Ltd.	Lupin Ltd.	Sun Pharmaceutical Industries Ltd.
2010-11	Standard	464	610	384	214
	Actual	464	701	491	214
	Saving	**0**	**91**	**107**	**0**
2011-12	Standard	482	704	411	255
	Actual	672	799	536	292
	Saving	**190**	**95**	**125**	**37**
2012-13	Standard	515	831	509	148
	Actual	811	953	597	197
	Saving	**296**	**122**	**88**	**49**
2013-14	Standard	571	904	644	157
	Actual	980	904	644	213
	Saving	**409**	**0**	**0**	**56**
2014-15	Standard	589	938	670	447
	Actual	1080	1069	755	1066
	Saving	**491**	**131**	**85**	**619**
2015-16	Standard	771	995	804	433
	Actual	1215	1161	808	1005
	Saving	**444**	**166**	**4**	**572**
2016-17	Standard	676	968	886	435
	Actual	1127	1176	915	978
	Saving	**451**	**208**	**29**	**543**
2017-18	Standard	680	867	701	479
	Actual	1132	1168	914	1026
	Saving	**452**	**301**	**213**	**547**
Total Savings		2732	1113	651	2422

Note: Amount has been rounded off to nearest ₹

Table 5.47 exhibits that the total possible savings in labour input would have been ₹ 2732 crore of Cipla Ltd. ₹ 1113 crore of Dr. Reddy's Laboratories Ltd., ₹ 651 crore of Lupin Ltd. and lastly ₹ 2422 crore of Sun Pharmaceutical Industries Ltd. For calculating possible savings, year of the lowest labour input output ratio has been taken as the base year.

1. Possible Savings in Salary, Wages, Bonus and Benefits of Pharmaceutical Sector Companies

The most important aspect of labour input is salary, wages, bonus and benefits. For analyzing this possible savings has been calculated and results has been analysed.

Table 5.48

Possible Savings in Salary, Wages, Bonus and Benefits of Pharmaceutical Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Cipla Ltd.	Dr. Reddy's Laboratories Ltd.	Lupin Ltd.	Sun Pharmaceutical Industries Ltd.
2010-11	Standard	394	505	315	176
	Actual	394	566	417	176
	Saving	**0**	**61**	**102**	**0**
2011-12	Standard	409	582	337	210
	Actual	590	660	451	250
	Saving	**181**	**78**	**114**	**40**
2012-13	Standard	437	687	418	122
	Actual	714	790	507	153
	Saving	**277**	**103**	**89**	**31**
2013-14	Standard	485	748	529	130
	Actual	820	748	529	179
	Saving	**335**	**0**	**0**	**49**
2014-15	Standard	500	776	549	368
	Actual	903	879	585	917
	Saving	**403**	**103**	**36**	**549**
2015-16	Standard	655	824	660	357
	Actual	1032	974	661	860
	Saving	**377**	**150**	**1**	**503**
2016-17	Standard	574	801	727	358
	Actual	1004	997	744	898
	Saving	**430**	**196**	**17**	**540**
2017-18	Standard	578	717	575	394
	Actual	1004	990	746	936
	Saving	**426**	**273**	**171**	**542**
Total Savings		2429	964	531	2255

Note: Amount has been rounded off to nearest ₹

Table 5.48 conveys that the total possible savings for a period of eight years might have been ₹ 2429 crore of Cipla Ltd., ₹ 964 crore of Dr. Reddy's Laboratories Ltd., ₹ 531 crore of Lupin Ltd. and lastly ₹ 2255 crore of Sun Pharmaceutical Industries Ltd. For calculating possible savings year of the lowest salary, wages, bonus and benefits input output ratio has been taken as the base year. The year 2010-11 has been regarded as the base year for Cipla Ltd. and Sun Pharmaceutical Industries Ltd. For Dr. Reddy's Laboratories Ltd. and Lupin Ltd. base year is 2013-14.

2. Possible Savings in Contribution to Provident and Other Funds of Pharmaceutical Sector Companies

An attempt has been made to calculate the possible savings in contribution to provident and other funds.

Table 5.49

Possible Savings in Contribution to Provident and Other Funds of Pharmaceutical Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Cipla Ltd.	Dr. Reddy's Laboratories Ltd.	Lupin Ltd.	Sun Pharmaceutical Industries Ltd.
2010-11	Standard	26	28	28	12
	Actual	26	40	47	12
	Saving	**0**	**12**	**19**	**0**
2011-12	Standard	27	33	29	14
	Actual	32	33	49	16
	Saving	**5**	**0**	**20**	**2**
2012-13	Standard	29	39	36	8
	Actual	37	47	51	17
	Saving	**8**	**8**	**15**	**9**
2013-14	Standard	32	42	46	9
	Actual	42	42	53	10
	Saving	**10**	**0**	**7**	**1**
2014-15	Standard	33	44	48	25
	Actual	46	52	70	70
	Saving	**13**	**8**	**22**	**45**
2015-16	Standard	43	46	58	24
	Actual	51	70	66	77
	Saving	**8**	**24**	**8**	**53**
2016-17	Standard	38	45	63	24
	Actual	72	65	63	54
	Saving	**34**	**20**	**0**	**30**
2017-18	Standard	38	40	50	27
	Actual	63	69	72	66
	Saving	**25**	**29**	**22**	**39**
Total Savings		104	101	113	180

Note: Amount has been rounded off to nearest ₹

Table 5.49 displays that Cipla Ltd. would have saved ₹ 104 crore, Dr. Reddy's Laboratories Ltd. ₹ 101 crore, Lupin Ltd. ₹ 113 crore and lastly ₹ 180 crore of savings would be possible of Sun Pharmaceutical Industries Ltd.

3. **Possible Savings in Employees Welfare Expenses and Others of Pharmaceutical Sector Companies**

The next segment of labour input is employees welfare expenses and others. For analyzing this possible savings has been calculated and results has been analysed.

Table 5.50

Possible Savings in Employees Welfare Expenses and Others of Pharmaceutical Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Cipla Ltd.	Dr. Reddy's Laboratories Ltd.	Lupin Ltd.	Sun Pharmaceutical Industries Ltd.
2010-11	Standard	35	72	27	11
	Actual	44	96	27	26
	Saving	**9**	**24**	**0**	**15**
2011-12	Standard	37	83	29	13
	Actual	50	106	37	26
	Saving	**13**	**23**	**8**	**13**
2012-13	Standard	39	98	36	7
	Actual	60	115	39	27
	Saving	**21**	**17**	**3**	**20**
2013-14	Standard	43	106	45	8
	Actual	118	114	63	24
	Saving	**75**	**8**	**18**	**16**
2014-15	Standard	45	110	47	22
	Actual	131	138	100	79
	Saving	**86**	**28**	**53**	**57**
2015-16	Standard	59	117	57	21
	Actual	133	117	81	69
	Saving	**74**	**0**	**24**	**48**
2016-17	Standard	52	113	62	21
	Actual	52	113	108	26
	Saving	**0**	**0**	**46**	**5**
2017-18	Standard	52	102	49	23
	Actual	65	109	96	23
	Saving	**13**	**7**	**47**	**0**
Total Savings		291	108	198	174

Note: Amount has been rounded off to nearest ₹

Table 5.50 manifests that the minimum possible savings would have been ₹ 108 crore of Dr. Reddy's Laboratories Ltd. if its input is optimally utilized while Cipla Ltd. would have saved as high as ₹ 291 crore during the study period.

5.7.6. Possible Savings in Labour Input of Refineries Sector Companies

Possible savings in labour input along with its all the three sections has been stated below.

Table 5.51

Possible Savings in Labour Input of Refineries Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bharat Petroleum Corporation Ltd.	Hindustan Petroleum Corporation Ltd.	Indian Oil Corporation Ltd.	Reliance Industries Ltd.
2010-11	Standard	1149	1117	3755	1959
	Actual	2803	1982	6436	2624
	Saving	**1654**	**865**	**2681**	**665**
2011-12	Standard	1487	1393	4597	2431
	Actual	2087	1461	4597	2642
	Saving	**600**	**68**	**0**	**211**
2012-13	Standard	1569	1523	4400	2477
	Actual	2318	2114	6086	2807
	Saving	**749**	**591**	**1686**	**330**
2013-14	Standard	1609	1549	4462	2571
	Actual	2210	1549	5050	2571
	Saving	**601**	**0**	**588**	**0**
2014-15	Standard	1495	1453	4170	2163
	Actual	1495	1731	5094	2643
	Saving	**0**	**278**	**924**	**480**
2015-16	Standard	1222	1287	3431	1619
	Actual	1955	1572	5186	2893
	Saving	**733**	**285**	**1755**	**1274**
2016-17	Standard	1246	1288	3302	1599
	Actual	2236	1921	6337	2891
	Saving	**990**	**633**	**3035**	**1292**
2017-18	Standard	1455	1508	3949	1862
	Actual	2175	1812	6390	3005
	Saving	**720**	**304**	**2441**	**1143**
Total Savings		6047	3024	13110	5394

Note: Amount has been rounded off to nearest ₹

Table 5.51 highlighted the total possible savings in labour input for a period of eight years would have been ₹ 6047 crore of Bharat Petroleum Corporation Ltd. with 2014-15 as a base year, ₹ 3024 crore of Hindustan Petroleum Corporation Ltd. with 2013-14 as a base year, ₹ 13110 crore of Indian Oil Corporation Ltd. with 2011-12 as a base year and lastly ₹ 5394 crore of Reliance Industries Ltd. with 2013-14 as a base year.

1. **Possible Savings in Salary, Wages, Bonus and Benefits of Refineries Sector Companies**

The most important part of labour input is salary, wages, bonus and benefits. For analyzing this possible savings has been calculated and results has been analysed.

Table 5.52

Possible Savings in Salary, Wages, Bonus and Benefits of Refineries Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bharat Petroleum Corporation Ltd.	Hindustan Petroleum Corporation Ltd.	Indian Oil Corporation Ltd.	Reliance Industries Ltd.
2010-11	Standard	771	815	2678	1661
	Actual	1507	1246	3916	2179
	Saving	**736**	**431**	**1238**	**518**
2011-12	Standard	998	1012	3290	2062
	Actual	1553	1012	3290	2246
	Saving	**555**	**0**	**0**	**184**
2012-13	Standard	1053	1111	3137	2101
	Actual	1793	1403	3630	2448
	Saving	**740**	**292**	**493**	**347**
2013-14	Standard	1080	1132	3181	2195
	Actual	1657	1170	3858	2195
	Saving	**577**	**38**	**677**	**0**
2014-15	Standard	1002	1060	2973	1835
	Actual	1002	1242	3542	2241
	Saving	**0**	**182**	**569**	**406**
2015-16	Standard	820	939	2447	1373
	Actual	1396	1111	3559	2533
	Saving	**576**	**172**	**1112**	**1160**
2016-17	Standard	836	939	2354	1356
	Actual	1473	1295	4349	2536
	Saving	**637**	**356**	**1995**	**1180**
2017-18	Standard	977	1100	2816	1579
	Actual	1594	1454	4803	2572
	Saving	**617**	**354**	**1987**	**993**
Total Savings		4439	1826	8070	4788

Note: Amount has been rounded off to nearest ₹

Table 5.52 displays that the total possible savings for a period of eight years is ₹ 4439 crore of Bharat Petroleum Corporation Ltd., ₹ 1826 crore of Hindustan Petroleum Corporation Ltd., ₹ 8070 crore of Indian Oil Corporation Ltd. and lastly ₹ 4788 crore of Reliance Industries Ltd.

2. **Possible Savings in Contribution to Provident and Other Funds of Refineries Sector Companies**

Another important chunk to discuss and analyse is contribution to provident and other funds. An attempt has been made to calculate its possible savings.

Table 5.53

Possible Savings in Contribution to Provident and Other Funds of Refineries Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bharat Petroleum Corporation Ltd.	Hindustan Petroleum Corporation Ltd.	Indian Oil Corporation Ltd.	Reliance Industries Ltd.
2010-11	Standard	121	53	555	124
	Actual	969	76	1626	243
	Saving	**848**	**23**	**1071**	**119**
2011-12	Standard	156	71	660	154
	Actual	253	71	660	198
	Saving	**97**	**0**	**0**	**44**
2012-13	Standard	165	72	650	157
	Actual	277	113	1548	182
	Saving	**112**	**41**	**898**	**25**
2013-14	Standard	169	73	660	178
	Actual	251	89	700	178
	Saving	**82**	**16**	**40**	**0**
2014-15	Standard	163	68	616	137
	Actual	163	83	879	213
	Saving	**0**	**15**	**263**	**76**
2015-16	Standard	129	61	507	102
	Actual	290	82	1202	153
	Saving	**161**	**21**	**695**	**51**
2016-17	Standard	131	61	488	101
	Actual	524	85	1410	149
	Saving	**393**	**24**	**922**	**48**
2017-18	Standard	153	71	584	118
	Actual	240	90	961	156
	Saving	**87**	**19**	**377**	**38**
Total Savings		1779	160	4265	401

Note: Amount has been rounded off to nearest ₹

Table 5.53 demonstrates that the total possible savings in contribution to provident and other funds for a period of eight years of Indian Oil Corporation Ltd. might have been as high as ₹ 4265 crore, followed by ₹ 1779 crore of Bharat Petroleum Corporation Ltd., Reliance Industries Ltd. ₹ 401 crore and lastly ₹ 160 crore of savings might be possible of Hindustan Petroleum Corporation Ltd. .

3. **Possible savings in Employees Welfare expenses and Others of Refineries Sector Companies**

Another factor of labour input is employees welfare expenses and others. For analyzing this possible savings has been calculated and results has been analysed.

Table 5.54

Possible Savings in Employees Welfare Expenses and Others of Refineries Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bharat Petroleum Corporation Ltd.	Hindustan Petroleum Corporation Ltd.	Indian Oil Corporation Ltd.	Reliance Industries Ltd.
2010-11	Standard	181	197	425	149
	Actual	326	660	894	202
	Saving	**145**	**463**	**469**	**53**
2011-12	Standard	235	246	519	198
	Actual	281	378	646	198
	Saving	**46**	**132**	**127**	**0**
2012-13	Standard	247	269	497	177
	Actual	247	599	909	177
	Saving	**0**	**330**	**412**	**0**
2013-14	Standard	254	274	492	198
	Actual	302	290	492	198
	Saving	**48**	**16**	**0**	**0**
2014-15	Standard	237	256	471	164
	Actual	330	406	673	189
	Saving	**93**	**150**	**202**	**25**
2015-16	Standard	193	227	388	123
	Actual	270	378	424	206
	Saving	**77**	**151**	**36**	**83**
2016-17	Standard	197	227	373	121
	Actual	239	541	577	206
	Saving	**42**	**314**	**204**	**85**
2017-18	Standard	230	269	446	141
	Actual	342	269	625	278
	Saving	**112**	**0**	**179**	**137**
Total Savings		563	1556	1628	382

Note: Amount has been rounded off to nearest ₹

Table 5.54 illustrates that ₹ 1628 crore would be the possible savings of Indian Oil Corporation Ltd. if its input is optimally utilized as compared to other companies under the refineries sector.

5.8. Comparative Analysis of Average Labour Productivity Ratios

To analyse between the companies of a particular sector it is better to analyse its average performance for the study period. In the present study an attempt has been made to analyse and interpret the results on the basis of average performance.

Table 5.55

Comparative Analysis of Average Labour Productivity Ratios of Automobile Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Salary, Wages, Bonus and Benefits (Input Output Ratio)		Contribution to Provident and Other Funds (Input Output Ratio)		Employees Welfare Expenses and Others (Input Output Ratio)		Total Labour (Input Output Ratio)		Labour Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
Bajaj Auto Ltd.	0.0263	2	0.0031	2	0.0022	2	0.0316	2	31.8770	2	3.016	1
Mahindra & Mahindra Ltd.	0.0402	3	0.0040	3	0.0056	3	0.0498	3	20.2732	3	4.749	2
Maruti Suzuki India Ltd.	0.0225	1	0.0012	1	0.0018	1	0.0256	1	39.8114	1	5.068	3
Tata Motors Ltd.	0.0488	4	0.0042	4	0.0062	4	0.0593	4	17.2582	4	13.193	4

Salary, Wages, Bonus and Benefits Average Input Output Ratio: The salary, wages, bonus and benefits average input output ratio is the best of Maruti Suzuki India Ltd. by 0.0225, followed by Bajaj Auto Ltd. by 0.0263, Mahindra & Mahindra Ltd. by 0.0402 and lastly Tata Motors Ltd. by 0.0488.

Contribution to Provident and Other Funds Average Input Output Ratio: It is the best of Maruti Suzuki India Ltd. as compared to Bajaj Auto Ltd., Mahindra & Mahindra Ltd. and Tata Motors Ltd.

Employees Welfare Expenses and Others Average Input Output Ratio: It is 0.0018 of Maruti Suzuki India Ltd., 0.0022 of Bajaj Auto Ltd, 0.0056 of Mahindra & Mahindra Ltd. and lastly 0.0062 of Tata Motors Ltd.

Total Labour Average Input Output Ratio: The total labour average input output ratio is the best of Maruti Suzuki India Ltd. with 0.0256, followed by Bajaj Auto Ltd. with 0.0316, Mahindra & Mahindra Ltd. 0.0498 and lastly Tata Motors Ltd. with 0.0593.

Average Labour Productivity Ratio: Average labour productivity ratio is the best of Maruti Suzuki India Ltd. with 39.8114 which means that for one ₹ of labour input, the output produced is approximately ₹ 40. This is followed by Bajaj Auto Ltd. with 31.8770, Mahindra & Mahindra Ltd. with 20.2732 and lastly Tata Motors Ltd. with 17.2582.

Chi-square Test: On analysing the chi-square of the automobile sector companies included in Nifty 50 it has been observed that Bajaj Auto Ltd. has the least chi-square value with 3.016 then the Mahindra and Mahindra Ltd. with 4.749 followed by Maruti Suzuki India Ltd. with 5.068 and lastly it is Tata Motors Ltd.

with the highest chi-square value 13.193. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square is accepted in all the above cases. This means that the alternative hypothesis is rejected. This reveals that the labour productivity ratios of all the companies of automobile sector included in Nifty 50 for the eight years period are approximately the same.

Table 5.56

Comparative Analysis of Average Labour Productivity Ratios of Energy Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Salary, Wages, Bonus and Benefits (Input Output Ratio)		Contribution to Provident and Other Funds (Input Output Ratio)		Employees Welfare Expenses and Others (Input Output Ratio)		Total Labour (Input Output Ratio)		Labour Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
GAIL (India) Ltd.	0.0118	1	0.0025	1	0.0026	1	0.0169	1	60.9335	1	26.646	4
NTPC Ltd.	0.0329	2	0.0071	2	0.0054	2	0.0454	2	22.1025	2	1.443	1
Oil and Natural Gas Corporation Ltd.	0.0693	4	0.0083	3	0.0193	4	0.0968	4	10.4527	4	9.346	2
Power Grid Corporation of India Ltd.	0.0399	3	0.0098	4	0.0068	3	0.0566	3	19.1242	3	10.289	3

Salary, Wages, Bonus and Benefits Average Input Output Ratio: It is the best of GAIL (India) Ltd. by 0.0118, followed by NTPC Ltd. by 0.0329, Power Grid Corporation of India Ltd. by 0.0399 and lastly Oil and Natural Gas Corporation Ltd. by 0.0693.

Contribution to Provident and Other Funds Average Input Output Ratio: It is the best of GAIL (India) Ltd. as compared to the other companies under study of the energy sector.

Employees Welfare Expenses and Others Average Input Output Ratio: It is 0.0026 of GAIL (India) Ltd., 0.0054 of NTPC Ltd., 0.0068 of Power Grid Corporation of India Ltd. and lastly 0.0193 of Oil and Natural Gas Corporation Ltd.

Total Labour Average Input Output Ratio: The total labour average input output ratio is the best of GAIL (India) Ltd. with 0.0169, followed by NTPC Ltd. with 0.0454, Power Grid Corporation of India Ltd. with 0.0566 and lastly Oil and Natural Gas Corporation Ltd. with 0.0968.

Average Labour Productivity Ratio: Average labour productivity ratio is the best of GAIL (India) Ltd. with 60.9335 which means that for one ₹ of labour input, the output produced is approximately ₹ 61. This is followed by NTPC Ltd.

with 22.1025, Power Grid Corporation of India Ltd. with 19.1242 and lastly Oil and Natural Gas Corporation Ltd. with 10.4527.

Chi-square Test: On analysing the chi-square of the energy sector companies it has been observed that NTPC Ltd. has the least chi-square value with 1.443 then the Oil and Natural Gas Corporation Ltd. with 9.346, followed by Power Grid Corporation Ltd. with 10.289 and lastly it is GAIL (India) Ltd. with the highest chi-square value 26.646. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square is accepted and alternative hypothesis is rejected in all the above cases except GAIL (India) Ltd. This reveals that the labour productivity ratios of the companies other than GAIL (India) Ltd. of energy sector included in Nifty 50 for the eight years period are approximately the same.

Table 5.57

Comparative Analysis of Average Labour Productivity Ratios of Information Technology Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Salary, Wages, Bonus and Benefits (Input Output Ratio)		Contribution to Provident and Other Funds (Input Output Ratio)		Employees Welfare Expenses and Others (Input Output Ratio)		Total Labour (Input Output Ratio)		Labour Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
Infosys Ltd.	0.4312	4	0.0099	2	0.0016	1	0.4428	4	2.2775	4	1.972	1
Tata Consultancy Services Ltd.	0.2988	1	0.0195	3	0.0168	4	0.3351	1	3.0284	2	11.706	4
Tech Mahindra Ltd.	0.3101	2	0.0252	4	0.0064	2	0.3417	2	3.0551	1	8.528	3
Wipro Ltd.	0.3785	3	0.0083	1	0.0101	3	0.3969	3	2.5347	3	2.177	2

Salary, Wages, Bonus and Benefits Average Input Output Ratio: It is the best of Tata Consultancy Services Ltd. followed by Tech Mahindra Ltd., Wipro Ltd. and Infosys Ltd.

Contribution to Provident and Other Funds Average Input Output Ratio: It is the best of Wipro Ltd. as compared to Infosys Ltd., Tata Consultancy Services Ltd. and Tech Mahindra Ltd.

Employees Welfare Expenses and Others Average Input Output Ratio: It is 0.0016 of Infosys Ltd., 0.0168 of Tata Consultancy Services Ltd., 0.0064 of Tech Mahindra Ltd. and lastly 0.0101 of Wipro Ltd.

Total Labour Average Input Output Ratio: The total labour average input output ratio is the best of Tata Consultancy Services Ltd. as compared to other companies of information technology sector.

Average Labour Productivity Ratio: Average labour productivity ratio is the best of Tech Mahindra Ltd. with 3.0551. This is followed by Tata Consultancy Services Ltd. then Wipro Ltd. and lastly Infosys Ltd.

Chi-square Test: On analysing the chi-square of the information technology sector companies it has been observed and analysed that Infosys Ltd. has the lowest chi-square value with 1.972 then the Wipro Ltd. with 2.177, followed by Tech Mahindra Ltd. with 8.528 and lastly it is Tata Consultancy Services Ltd with the highest chi-square value 11.706. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square is accepted in all the above cases reveals that the labour productivity ratios of all the companies of information technology sector for the eight years period are approximately the same.

Table 5.58

Comparative Analysis of Average Labour Productivity Ratios of Metals Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Salary, Wages, Bonus and Benefits (Input Output Ratio)		Contribution to Provident and Other Funds (Input Output Ratio)		Employees Welfare Expenses and Others (Input Output Ratio)		Total Labour (Input Output Ratio)		Labour Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
Coal India Ltd.	0.0189	1	0.0020	1	0.0081	4	0.0290	2	38.3420	2	107.206	4
Hindalco Ltd.	0.0323	3	0.0045	3	0.0037	2	0.0405	3	24.8515	3	1.324	1
Tata Steel Ltd.	0.0688	4	0.0097	4	0.0050	3	0.0836	4	12.2288	4	8.106	2
Vedanta Ltd.	0.0198	2	0.0020	1	0.0022	1	0.0240	1	56.4281	1	72.090	3

Salary, Wages, Bonus and Benefits Average Input Output Ratio: The salary, wages, bonus and benefits average input output ratio is the best of Coal India Ltd. by 0.0189, followed by Vedanta Ltd. by 0.0198, Hindalco Ltd. by 0.0323 and lastly Tata Steel Ltd. by 0.0688.

Contribution to Provident and Other Funds Average Input Output Ratio: It is the best of Coal India Ltd. and Vedanta Ltd. as compared to other companies of metals sector.

Employees Welfare Expenses and Others Average Input Output Ratio: It is 0.0022 of Vedanta Ltd., 0.0037 of Hindalco Ltd., 0.0050 of Tata Steel Ltd. and lastly 0.0081 of Coal India Ltd.

Total Labour Average Input Output Ratio: The total labour average input output ratio is the best of Vedanta Ltd. with 0.0240, followed by Coal India Ltd. with 0.0290, Hindalco Ltd. with 0.0405 and lastly Tata Steel Ltd. with 0.0836.

Average Labour Productivity Ratio: Average labour productivity ratio is the best of Vedanta Ltd. with 56.4281. This is followed by Coal India Ltd. with 38.3420 then Hindalco Ltd. with 24.8515 and lastly Tata Steel Ltd. with 12.2288.

Chi-square Test: On analysing the chi-square of the metals sector companies it has been observed that Hindalco Ltd. has the least chi-square value with 1.324 then the Tata Steel Ltd. with 8.106, followed by Vedanta Ltd. with 72.090 and lastly it is Coal India Ltd. with the highest chi-square value 107.206. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square is accepted in Hindalco Ltd. and Tata Steel Ltd. while it is rejected in Vedanta Ltd. and Coal India Ltd.

Table 5.59

Comparative Analysis of Average Labour Productivity Ratios of Pharmaceutical Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Salary, Wages, Bonus and Benefits (Input Output Ratio)		Contribution to Provident and Other Funds (Input Output Ratio)		Employees Welfare Expenses and Others (Input Output Ratio)		Total Labour (Input Output Ratio)		Labour Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
Cipla Ltd.	0.0987	3	0.0056	1	0.0100	3	0.1143	3	9.0271	3	10.719	3
Dr. Reddy's Laboratories Ltd.	0.1103	4	0.0070	2	0.0154	4	0.1326	4	7.5841	4	3.294	1
Lupin Ltd.	0.0808	1	0.0083	4	0.0090	2	0.0982	1	10.3079	1	9.013	2
Sun Pharmaceutical Industries Ltd.	0.0976	2	0.0072	3	0.0081	1	0.1129	2	9.8738	2	12.135	4

Salary, Wages, Bonus and Benefits Average Input Output Ratio: It is the best of Lupin Ltd. followed by Sun Pharmaceutical Industries Ltd., Cipla Ltd. and lastly Dr. Reddy's Laboratories Ltd.

Contribution to Provident and Other Funds Average Input Output Ratio: It is the best of Cipla Ltd. as compared to Dr. Reddy's Laboratories Ltd., Sun Pharmaceutical Industries Ltd. and Lupin Ltd.

Employees Welfare Expenses and Others Average Input Output Ratio: It is 0.0081 of Sun Pharmaceutical Industries Ltd., 0.0090 of Lupin Ltd, 0.0100 of Cipla Ltd. and lastly 0.0154 of Dr. Reddy's Laboratories Ltd.

Total Labour Average Input Output Ratio: The total labour average input output ratio is the best of Lupin Ltd. with 0.0982, followed by Sun Pharmaceutical Industries Ltd. with 0.1129, Cipla Ltd. with 0.1143 and lastly Dr. Reddy's Laboratories Ltd. with 0.1326.

Average Labour Productivity Ratio: Average labour productivity ratio is the best of Lupin Ltd. with 10.3079 which means that for one ₹ of labour input, the output produced is approximately ₹ 10. This is followed by Sun Pharmaceutical Industries Ltd. with 9.8738, then Cipla Ltd. with 9.0271 and lastly Dr. Reddy's Laboratories Ltd. with 7.5841.

Chi-square Test: On analysing the chi-square of the pharmaceutical sector companies included in Nifty 50 it has been observed that to Dr. Reddy's Laboratories Ltd. has the least chi-square value with 3.294, then the Lupin Ltd. with 9.013, followed by Cipla Ltd. with 10.719 and lastly it is Sun Pharmaceutical Industries Ltd. with the highest chi-square value 12.135. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square is accepted in all the above cases. This means that the alternative hypothesis is rejected. This reveals that the labour productivity ratios of all the companies of pharmaceutical sector included in Nifty 50 for the eight years period are approximately the same.

Table 5.60

Comparative Analysis of Average Labour Productivity Ratios of Refineries Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Salary, Wages, Bonus and Benefits (Input Output Ratio)		Contribution to Provident and Other Funds (Input Output Ratio)		Employees Welfare Expenses and Others (Input Output Ratio)		Total Labour (Input Output Ratio)		Labour Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
Bharat Petroleum Corporation Ltd.	0.0082	2	0.0022	3	0.0016	2	0.0120	3	88.5134	3	69.482	4
Hindustan Petroleum Corporation Ltd.	0.0077	1	0.0005	1	0.0028	4	0.0110	2	94.1102	2	32.335	2
Indian Oil Corporation Ltd.	0.0113	4	0.0033	4	0.0019	3	0.0165	4	63.1303	4	33.676	3
Reliance Industries Ltd.	0.0093	3	0.0007	2	0.0008	1	0.0109	1	96.5455	1	19.682	1

Salary, Wages, Bonus and Benefits Average Input Output Ratio: The salary, wages, bonus and benefits average input output ratio is the best of Hindustan

Petroleum Corporation Ltd. by 0.0077, followed by Bharat Petroleum Corporation Ltd. by 0.0082, Reliance Industries Ltd. by 0.0093 and lastly Indian Oil Corporation Ltd. by 0.0113.

Contribution to Provident and Other Funds Average Input Output Ratio: It is the best of Hindustan Petroleum Corporation Ltd. as compared to other companies under study of refineries sector.

Employees Welfare Expenses and Others Average Input Output Ratio: It is 0.0008 of Reliance Industries Ltd., 0.0016 of Bharat Petroleum Corporation Ltd., 0.0019 of Indian Oil Corporation Ltd. and lastly 0.0028 of Hindustan Petroleum Corporation Ltd.

Total Labour Average Input Output Ratio: The total labour average input output ratio is the best of Reliance Industries Ltd. with 0.0109, followed by Hindustan Petroleum Corporation Ltd. with 0.0110, Bharat Petroleum Corporation Ltd. with 0.0120 and lastly Indian Oil Corporation Ltd. with 0.0165.

Average Labour Productivity Ratio: Average labour productivity ratio is the best of Reliance Industries Ltd. with 96.5455. This is followed by Hindustan Petroleum Corporation Ltd. with 94.1102 then Bharat Petroleum Corporation Ltd. with 88.5134 and lastly Indian Oil Corporation Ltd. with 63.1303.

Chi-square Test: On analysing the chi-square of the refineries sector companies included in Nifty 50 it has been observed that Reliance Industries Ltd. has the least chi-square value with 19.682 then the Hindustan Petroleum Corporation Ltd. with 32.335, followed by Indian Oil Corporation Ltd. with 33.676 and lastly it is Bharat Petroleum Corporation Ltd. with the highest chi-square value 69.482. The table value of chi-square at 5% level of significance with (8 - 1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square is rejected in all the above cases. This means that the alternative hypothesis is accepted. This reveals that the labour productivity ratios of all the companies of refineries sector for the eight years period are not approximately the same.

5.9. Concluding Observations

This chapter highlights the labour element of overall input. The total labour expenses have been categorised into three heads viz., firstly, salary, wages, bonus and benefits, secondly, contribution to provident and other funds and lastly,

employees welfare expenses and others. On concentrating the objectives of the study two types of hypotheses have been developed, viz., intra-company and inter-company. For intra-company hypothesis, chi-square test has been used for testing the hypothesis while for inter-company hypothesis kruskal wallis one way analysis of variance test has been used and result indicated that null hypothesis is rejected in all the sectors under study. Possible savings has also been calculated indicating what would have been saved if the labour input is optimally utilised by adopting technique which can reduce the labour turnover and other problems related to labour.

The next chapter deals with the overhead aspect of overall productivity. The expenses which should be covered under the head 'Overhead' will be discussed there.

Appendices

Appendix 5.1 to 5.4. Revaluation of Labour Input of Automobile Sector Companies

Appendix 5.1

Revaluation of Labour Input of Bajaj Auto Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	389.14	448.59	414.05	520.88	435.98	609.61	465.13	707.77	507.47	790.35	536.65	863.89	563.26	927.39	587.97
2	Contribution to Provident and Other Funds	61.45	49.50	45.69	68.79	57.58	64.62	49.31	130.41	93.50	69.43	47.14	69.19	45.11	80.55	51.07
3	Employees Welfare Expenses and Others	42.99	42.02	38.78	49.81	41.69	52.35	39.94	59.12	42.39	58.66	39.83	63.99	41.72	61.15	38.77
	Total Labour Input	493.58	540.11	498.52	639.48	535.24	726.58	554.38	897.30	643.36	918.44	623.62	997.07	650.09	1069.09	677.80

Appendix 5.2

Revaluation of Labour Input of Mahindra & Mahindra Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	1157.16	1326.46	1224.32	1524.00	1275.59	1749.67	1335.00	1884.12	1350.91	1889.23	1282.79	2189.68	1427.67	2319.45	1470.53
2	Contribution to Provident and Other Funds	134.61	143.06	132.04	123.03	102.98	178.63	136.29	213.05	152.76	172.36	117.03	195.26	127.31	207.72	131.69
3	Employees Welfare Expenses and Others	139.75	232.26	214.38	219.42	183.65	235.42	179.63	219.76	157.57	280.56	190.50	329.49	214.83	313.72	198.90
	Total Labour Input	1431.52	1701.78	1570.74	1866.45	1562.22	2163.72	1650.92	2316.93	1661.24	2342.15	1590.32	2714.43	1769.81	2840.89	1801.12

Appendix 5.3

Revaluation of Labour Input of Maruti Suzuki India Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	625.60	760.60	702.03	915.20	766.02	1209.40	922.77	1412.70	1012.91	1739.30	1180.98	2077.20	1354.33	2494.10	1581.26
2	Contribution to Provident and Other Funds	30.30	33.00	30.46	66.90	56.00	68.90	52.57	91.10	65.32	98.30	66.75	95.20	62.07	131.10	83.12
3	Employees Welfare Expenses and Others	47.70	50.20	46.33	87.50	73.24	89.80	68.52	102.80	73.71	151.10	102.60	158.60	103.41	208.60	132.25
	Total Labour Input	703.60	843.80	778.83	1069.60	895.26	1368.10	1043.86	1606.60	1151.93	1988.70	1350.33	2331.00	1519.81	2833.80	1796.63

Appendix 5.4

Revaluation of Labour Input of Tata Motors Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	1841.62	2193.80	2024.88	2312.15	1935.27	2355.59	1797.32	2524.43	1810.02	2548.89	1730.70	3179.05	2072.74	3311.57	2099.54
2	Contribution to Provident and Other Funds	219.49	210.55	194.34	207.53	173.70	218.94	167.05	225.78	161.88	172.15	116.89	209.11	136.34	236.16	149.73
3	Employees Welfare Expenses and Others	232.91	287.10	264.99	317.32	265.60	303.16	231.31	341.25	244.68	305.71	207.58	376.19	245.28	419.00	265.65
	Total Labour Input	2294.02	2691.45	2484.21	2837.00	2374.57	2877.69	2195.68	3091.46	2216.58	3026.75	2055.16	3764.35	2454.36	3966.73	2514.91

Appendix 5.5 to 5.8. Revaluation of Labour Input of Energy Sector Companies

Appendix 5.5

Revaluation of Labour Input of GAIL (India) Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary ,Wages, Bonus and Benefits	546.39	403.51	372.44	532.76	445.92	600.22	457.97	627.62	450.00	708.70	481.21	757.33	493.78	987.13	625.84
2	Contribution to Provident and Other Funds	60.27	83.51	77.08	131.59	110.14	114.83	87.62	131.42	94.23	149.30	101.37	337.70	220.18	121.25	76.87
3	Employees Welfare Expenses and Others	114.57	120.46	111.18	121.10	101.36	132.68	101.23	147.36	105.66	138.06	93.74	162.50	105.95	193.08	122.41
	Total Labour Input	721.23	607.48	560.70	785.45	657.42	847.73	646.82	906.40	649.89	996.06	676.32	1257.53	819.91	1301.46	825.13

Appendix 5.6

Revaluation of Labour Input of NTPC Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	2158.44	2499.52	2307.06	2632.71	2203.58	2424.16	1849.63	2522.76	1808.82	2520.96	1711.73	2805.54	1829.21	3552.25	2252.13
2	Contribution to Provident and Other Funds	337.83	295.86	273.08	372.41	311.71	999.36	762.51	520.45	373.16	543.58	369.09	1077.82	702.74	623.43	395.25
3	Employees Welfare Expenses and Others	293.44	295.10	272.38	355.00	297.14	444.47	339.13	577.50	414.07	544.78	369.91	441.24	287.69	558.99	354.40
	Total Labour Input	2789.71	3090.48	2852.51	3360.12	2812.42	3867.99	2951.28	3620.71	2596.05	3609.32	2450.73	4324.60	2819.64	4734.67	3001.78

Appendix 5.7

Revaluation of Labour Input of Oil and Natural Gas Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	5020.13	5165.28	4767.55	6817.01	5705.84	6424.14	4901.62	6826.10	4894.31	6458.63	4385.41	7440.27	4851.06	9213.52	5841.37
2	Contribution to Provident and Other Funds	328.37	754.47	696.38	446.00	373.30	902.65	688.72	944.70	677.35	989.10	671.60	1012.29	660.01	1139.66	722.54
3	Employees Welfare Expenses and Others	1379.71	876.3	808.82	3067.15	2567.20	3078.25	2348.70	859.09	615.97	1293.57	878.33	3098.21	2020.03	1027.87	651.67
	Total Labour Input	6728.21	6796.05	6272.75	10330.16	8646.34	10405.04	7939.05	8629.89	6187.63	8741.30	5935.34	11550.77	7531.10	11381.05	7215.59

Appendix 5.8

Revaluation of Labour Input of Power Grid Corporation of India Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	510.66	666.98	615.62	644.71	539.62	665.60	507.85	609.76	437.20	652.49	443.04	858.63	559.83	1300.55	824.55
2	Contribution to Provident and Other Funds	149.22	88.41	81.60	140.38	117.50	159.42	121.64	268.33	192.39	181.42	123.18	357.03	232.78	112.24	71.16
3	Employees Welfare Expenses and Others	86.01	87.58	80.84	101.31	84.80	116.66	89.01	145.56	104.37	146.63	99.56	161.47	105.28	193.10	122.43
	Total Labour Input	745.89	842.97	778.06	886.40	741.92	941.68	718.50	1023.65	733.96	980.54	665.79	1377.13	897.89	1605.89	1018.13

Appendix 5.9 to 5.12 Revaluation of Labour Input of Information Technology Sector Companies

Appendix 5.9

Revaluation of Labour Input of Infosys Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	11994.00	15019.00	13862.54	19523.00	16340.75	23852.00	18199.08	24509.00	17572.95	27551.00	18707.13	30111.00	19632.37	31618.00	20045.81
2	Contribution to Provident and Other Funds	410.00	405.00	373.82	378.00	316.39	432.00	329.62	519.00	372.12	547.00	371.41	640.00	417.28	695.00	440.63
3	Employees Welfare Expenses and Others	55.00	49.00	45.23	31.00	25.95	66.00	50.36	87.00	62.38	108.00	73.33	193.00	125.84	159.00	100.81
	Total Labour Input	12459.00	15473.00	14281.58	19932.00	16683.08	24350.00	18579.05	25115.00	18007.46	28206.00	19151.87	30944.00	20175.49	32472.00	20587.25

Appendix 5.10

Revaluation of Labour Input of Tata Consultancy Services Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	8884.06	12440.11	11482.22	15067.12	12611.18	19039.28	14526.97	24441.85	17524.81	26574.73	18044.24	43876.00	28607.15	47004.00	29800.54
2	Contribution to Provident and Other Funds	596.02	764.72	705.84	970.32	812.16	1163.88	888.04	1537.79	1102.60	1870.20	1269.87	2984.00	1945.57	3165.00	2006.61
3	Employees Welfare Expenses and Others	710.23	895.58	826.62	1044.28	874.06	1263.40	963.97	1388.68	995.68	1623.26	1102.19	1256.00	818.91	1330.00	843.22
	Total Labour Input	10190.31	14100.41	13014.68	17081.72	14297.40	21466.56	16378.99	27368.32	19623.09	30068.19	20416.30	48116.00	31371.63	51499.00	32650.37

Appendix 5.11

Revaluation of Labour Input of Tech Mahindra Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	1744.60	1979.10	1826.71	2273.20	1902.67	6450.50	4921.73	6534.40	4685.16	6790.90	4611.02	7132.10	4650.13	7499.20	4754.49
2	Contribution to Provident and Other Funds	121.60	171.40	158.20	208.90	174.85	488.70	372.88	593.90	425.83	562.90	382.21	559.30	364.66	519.40	329.30
3	Employees Welfare Expenses and Others	77.60	100.50	92.76	31.70	26.53	32.30	24.64	72.90	52.27	56.30	38.23	53.00	34.56	87.90	55.73
	Total Labour Input	1943.80	2251.00	2077.67	2513.80	2104.05	6971.50	5319.25	7201.20	5163.26	7410.10	5031.46	7744.40	5049.35	8106.50	5139.52

Appendix 5.12

Revaluation of Labour Input of Wipro Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	10292.30	12660.50	11685.64	15177.60	12703.65	17552.30	13392.40	18802.40	13481.32	20215.20	13726.12	21079.90	13744.09	20961.70	13289.72
2	Contribution to Provident and Other Funds	378.20	343.10	316.68	394.30	330.03	403.90	308.18	372.70	267.23	564.10	383.02	104.70	68.26	141.30	89.58
3	Employees Welfare Expenses and Others	266.90	307.90	284.19	332.30	278.14	381.30	290.93	551.20	395.21	600.40	407.67	669.80	436.71	653.20	414.13
	Total Labour Input	10937.40	13311.50	12286.51	15904.20	13311.82	18337.50	13991.51	19726.30	14143.76	21379.70	14516.82	21854.40	14249.07	21756.20	13793.43

Appendix 5.13 to 4.16 Revaluation of Labour Input of Metals Sector Companies

Appendix 5.13

Revaluation of Labour Input of Coal India Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

		2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
S.No.	Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	181.25	209.08	192.98	231.25	193.56	254.10	193.88	252.78	181.24	255.74	173.65	254.60	166.00	265.97	168.62
2	Contribution to Provident and Other Funds	17.84	20.16	18.61	26.01	21.77	26.45	20.18	26.59	19.07	27.73	18.83	27.71	18.07	28.61	18.14
3	Employees Welfare Expenses and Others	52.02	79.80	73.66	89.50	74.91	74.45	56.81	87.21	62.53	95.85	65.08	133.32	86.92	230.46	146.11
	Total Labour Input	251.11	309.04	285.24	346.76	290.24	355.00	270.87	366.58	262.84	379.32	257.56	415.63	270.99	525.04	332.88

Appendix 5.14

Revaluation of Labour Input of Hindalco Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

		2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
S.No.	Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	788.98	890.37	821.81	971.55	813.19	1073.87	819.36	1218.56	873.71	1369.33	929.78	1440.84	939.43	1550.96	983.31
2	Contribution to Provident and Other Funds	146.57	120.07	110.82	117.69	98.51	150.20	114.60	227.99	163.47	175.36	119.07	150.96	98.43	178.80	113.36
3	Employees Welfare Expenses and Others	104.84	102.91	94.99	111.56	93.38	122.03	93.11	142.93	102.48	153.37	104.14	160.32	104.53	164.89	104.54
	Total Labour Input	1040.39	1113.35	1027.62	1200.80	1005.07	1346.10	1027.07	1589.48	1139.66	1698.06	1152.98	1752.12	1142.38	1894.65	1201.21

Appendix 5.15

Revaluation of Labour Input of Tata Steel Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

		2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
S.No.	Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	2106.52	2646.21	2442.45	2916.69	2441.27	3230.60	2464.95	3568.86	2558.87	3607.79	2449.69	3934.58	2565.35	4130.68	2618.85
2	Contribution to Provident and Other Funds	491.94	299.29	276.24	418.90	350.62	365.90	279.18	600.14	430.30	464.64	315.49	434.30	283.16	446.75	283.24
3	Employees Welfare Expenses and Others	239.00	101.76	93.92	266.68	223.21	76.58	58.43	432.92	310.40	252.47	171.43	236.25	154.04	251.42	159.40
	Total Labour Input	2837.46	3047.26	2812.62	3602.27	3015.10	3673.08	2802.56	4601.92	3299.58	4324.90	2936.61	4605.13	3002.54	4828.85	3061.49

Appendix 5.16

Revaluation of Labour Input of Vedanta Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

		2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
S.No.	Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	121.58	155.72	143.73	153.98	128.88	488.57	372.78	574.82	412.15	532.82	361.78	568.00	370.34	577.00	365.82
2	Contribution to Provident and Other Funds	13.53	17.67	16.31	17.16	14.36	33.90	25.87	34.00	24.38	26.28	17.84	80.00	52.16	85.00	53.89
3	Employees Welfare Expenses and Others	13.97	18.05	16.66	13.48	11.28	36.61	27.93	41.31	29.62	44.43	30.17	136.00	88.67	140.00	88.76
	Total Labour Input	149.08	191.44	176.70	184.62	154.53	559.08	426.58	650.13	466.14	603.53	409.80	784.00	511.17	802.00	508.47

Appendix 5.17 to 5.20 Revaluation of Labour Input of Pharmaceutical Sector Companies

Appendix 5.17

Revaluation of Labour Input of Cipla Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	394.44	639.33	590.10	853.35	714.25	1075.12	820.32	1259.01	902.71	1519.34	1031.63	1540.14	1004.17	1582.96	1003.60
2	Contribution to Provident and Other Funds	26.16	34.38	31.73	44.4	37.16	54.6	41.66	63.74	45.70	74.49	50.58	109.71	71.53	100.11	63.47
3	Employees Welfare Expenses and Others	43.6	54.5	50.30	71.53	59.87	155.03	118.29	182.83	131.09	195.82	132.96	79.12	51.59	102.87	65.22
	Total Labour Input	464.20	728.21	672.14	969.28	811.29	1284.75	980.26	1505.58	1079.50	1789.65	1215.17	1728.97	1127.29	1785.94	1132.29

Appendix 5.18

Revaluation of Labour Input of Dr. Reddy's Laboratories Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	566.10	715.60	660.50	943.80	789.96	980.40	748.05	1225.70	878.83	1433.90	973.62	1529.20	997.04	1561.70	990.12
2	Contribution to Provident and Other Funds	39.50	35.30	32.58	56.70	47.46	55.20	42.12	72.80	52.20	103.60	70.34	100.20	65.33	109.30	69.30
3	Employees Welfare Expenses and Others	95.60	115.20	106.33	137.60	115.17	149.30	113.92	192.40	137.95	172.50	117.13	173.90	113.38	172.00	109.05
	Total Labour Input	701.20	866.10	799.41	1138.10	952.59	1184.90	904.08	1490.90	1068.98	1710.00	1161.09	1803.30	1175.75	1843.00	1168.46

Appendix 5.19

Revaluation of Labour Input of Lupin Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	417.30	488.09	450.51	605.59	506.88	692.89	528.68	816.07	585.12	972.78	660.52	1140.79	743.80	1176.59	745.96
2	Contribution to Provident and Other Funds	46.70	52.78	48.72	60.44	50.59	69.03	52.67	97.40	69.84	97.89	66.47	96.68	63.04	113.17	71.75
3	Employees Welfare Expenses and Others	27.23	40.35	37.24	47.05	39.38	82.40	62.87	139.08	99.72	119.99	81.47	165.56	107.95	151.88	96.29
	Total Labour Input	491.23	581.22	536.47	713.08	596.85	844.32	644.22	1052.55	754.68	1190.66	808.46	1403.03	914.78	1441.64	914.00

Appendix 5.20

Revaluation of Labour Input of Sun Pharmaceutical Industries Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	176.17	270.88	250.02	182.68	152.90	234.87	179.21	1279.16	917.16	1266.14	859.71	1377.90	898.39	1476.57	936.15
2	Contribution to Provident and Other Funds	11.88	17.05	15.74	20.03	16.77	13.62	10.39	97.41	69.84	113.23	76.88	82.58	53.84	104.20	66.06
3	Employees Welfare Expenses and Others	26.01	28.63	26.43	32.16	26.92	31.14	23.76	110.11	78.95	101.14	68.67	39.40	25.69	36.92	23.41
	Total Labour Input	214.06	316.56	292.18	234.87	196.59	279.63	213.36	1486.68	1065.95	1480.51	1005.27	1499.88	977.92	1617.69	1025.62

Appendix 5.21 to 5.24 Revaluation of Labour Input of Refineries Sector Companies

Appendix 5.21

Revaluation of Labour Input of Bharat Petroleum Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

		2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
S.No.	Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	1507.28	1682.24	1552.71	2142.70	1793.44	2171.72	1657.02	1397.77	1002.20	2055.48	1395.67	2259.96	1473.49	2514.25	1594.03
2	Contribution to Provident and Other Funds	969.09	273.89	252.80	330.58	276.70	329.39	251.32	227.33	163.00	426.37	289.51	802.99	523.55	377.83	239.54
3	Employees Welfare Expenses and Others	326.48	304.94	281.46	295.59	247.41	395.24	301.57	460.50	330.18	397.20	269.70	366.51	238.96	538.90	341.66
	Total Labour Input	2802.85	2261.07	2086.97	2768.87	2317.54	2896.35	2209.92	2085.60	1495.38	2879.05	1954.87	3429.46	2236.01	3430.98	2175.24

Appendix 5.22

Revaluation of Labour Input of Hindustan Petroleum Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

		2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
S.No.	Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	1246.26	1096.16	1011.76	1675.72	1402.58	1533	1169.68	1732.66	1242.32	1636.82	1111.40	1986.01	1294.88	2293.01	1453.77
2	Contribution to Provident and Other Funds	75.91	76.92	71.00	134.5	112.58	117.03	89.29	115.28	82.66	121.14	82.25	129.7	84.56	141.59	89.77
3	Employees Welfare Expenses and Others	659.67	410.02	378.45	715.34	598.74	380.27	290.15	566.72	406.34	556.57	377.91	830.37	541.40	423.92	268.77
	Total Labour Input	1981.84	1583.10	1461.20	2525.56	2113.89	2030.30	1549.12	2414.66	1731.31	2314.53	1571.57	2946.08	1920.84	2858.52	1812.30

Appendix 5.23

Revaluation of Labour Input of Indian Oil Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

		2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
S.No.	Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	3916.26	3564.37	3289.91	4336.41	3629.58	5056.63	3858.21	4940.13	3542.07	5242.25	3559.49	6670.77	4349.34	7576.49	4803.49
2	Contribution to Provident and Other Funds	1625.57	715.26	660.18	1849.08	1547.68	916.96	699.64	1226.01	879.05	1770.74	1202.33	2162.89	1410.20	1516.55	961.49
3	Employees Welfare Expenses and Others	893.72	700.43	646.50	1085.78	908.80	645.38	492.42	938.64	673.00	624.1	423.76	885.26	577.19	986.37	625.36
	Total Labour Input	6435.55	4980.06	4596.60	7271.27	6086.05	6618.97	5050.27	7104.78	5094.13	7637.09	5185.58	9718.92	6336.74	10079.41	6390.35

Appendix 5.24

Revaluation of Labour Input of Reliance Industries Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

		2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
S.No.	Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Salary, Wages, Bonus and Benefits	2179.21	2433.00	2245.66	2925.00	2448.23	2877.00	2195.15	3125.00	2240.63	3730.00	2532.67	3889.00	2535.63	4056.00	2571.50
2	Contribution to Provident and Other Funds	243.31	215.00	198.45	218.00	182.47	233.00	177.78	297.00	212.95	226.00	153.45	229.00	149.31	246.00	155.96
3	Employees Welfare Expenses and Others	201.65	214.00	197.52	211.00	176.61	260.00	198.38	264.00	189.29	304.00	206.42	316.00	206.03	438.00	277.69
	Total Labour Input	2624.17	2862.00	2641.63	3354.00	2807.30	3370.00	2571.31	3686.00	2642.86	4260.00	2892.54	4434.00	2890.97	4740.00	3005.16

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Chapter-6

Overhead Productivity

CHAPTER 6

OVERHEAD PRODUCTIVITY

6.1. Introduction

In the words of Saxena & Vashist, "All indirect costs form part of overhead, which is an aggregate of indirect material cost, indirect wages and cost of indirect service. Thus overhead is a pool of indirect costs, i.e., the costs which cannot be identified or linked or attributed or allocated to the cost objective."

According to CIMA London, "Overhead is the aggregate of indirect material cost, indirect wages (indirect labour cost) and indirect expenses." This means that the sum of all other expenses excluding the direct material, direct labour constitutes the overhead.

Indirect expenses are the expenses which are not related to any specific job, product or process but which are incurred for the business as a whole.

In the present study third important input is overhead. This chapter covers the measurement of overhead productivity in sampled companies.\

The content of this chapter is based on the article published by us in The Management Accountant Journal. (Reference No.4)

6.2. Steps in Measurement of Overhead Productivity

Following steps are to be taken for the measurement of overhead productivity:

1. Revaluation of Overhead Input at Base Year Prices.
2. Computation and Analysis of Overhead Productivity Ratios and Overhead Productivity Indices.
3. Testing Hypotheses.
4. Computation of Possible Savings.

6.2.1. Revaluation of Overhead Input at Base Year Prices

- Revaluation of overhead input at base year prices for different companies under the study has been carried out in Appendix 6.1 to 6.24.
- Revalued overhead input has been calculated for the period of eight years i.e. from 2010-11 to 2017-18. Overhead input in this study includes Power and

Fuel, Depreciation and Amortisation, Repairs and Maintenance and lastly Business Service Input. Business service input includes the other overhead expenses which are not able to classify in the specified overhead head.

- Monetary values of the Power and Fuel, Depreciation and Amortisation, Repairs and Maintenance and Business Service Input for the years covered by the study of different companies of different industries have been multiplied with the conversion factors. All the overhead inputs have been revalued with the different index numbers according to the nature of overheads. Power and Fuel has been revalued with the fuel and power index. Repairs and Maintenance and Business Service Input have been revalued with the wholesale price index. Depreciation and Amortisation has not been revalued at all as it is measured at historical cost of fixed assets.

6.2.2. Computation and Analysis of Overhead Productivity Ratios and Overhead Productivity Indices

- Overhead productivity ratio means output at base year prices per rupee of overhead input. For calculating this ratio revalued output (Refer Appendix 3.1 to 3.24) is divided by the revalued input (Refer Appendix 6.1 to 6.24).
- Overhead productivity indices have been calculated assuming base year 2010-11 overhead productivity ratio as 100.
- Overhead productivity index above 100 will indicate the improvement in the productivity as compared to the productivity of the base year while below 100 will mean low productivity as compared to the base year productivity. Overhead productivity ratios and indices have been calculated in the table 6.1 to 6.24.

6.2.3. Testing Hypotheses

The present study considers two hypotheses for the purpose of analyzing the overhead productivity ratios and indices.

- **For Intra-Company Comparison:** First hypothesis has been developed to measure, analyse and compare the overhead productivity indices of the sampled companies for the study period.

Null Hypothesis (H_0): There is no significant difference in the overhead productivity indices of the sampled company for the study period and can be represented by straight line trend or line of best fit.

Alternative Hypothesis (H_1): There is a significant difference in the overhead productivity indices of the sampled company for the study period and cannot be represented by straight line trend or line of best fit.

The acceptance of null hypothesis would reveal that the overhead productivity indices of the sampled company for the study period are approximately equal and can be represented by straight line trend or line of best fit. However, rejection of null hypothesis and acceptance of alternative hypothesis would mean that the overhead productivity indices of the sampled company differ in the study period indicates that indices cannot be represented by straight line trend. Above hypothesis will be tested with the help of chi-square test.

- **For Inter-Company Comparison:** Another hypothesis has been developed to study the inter-company relationship i.e. hypothesis developed to measure, analyse and compare the overhead productivity ratios of sampled companies.

  Null Hypothesis (H_0): There is no significant difference in the overhead productivity ratios of sampled companies.

  Alternative Hypothesis (H_1): There is a significant difference in the overhead productivity ratios of sampled companies.

  The acceptance of null hypothesis would reveal that the overhead productivity ratios of sampled companies are approximately equal. However, rejection of null hypothesis and acceptance of alternative hypothesis would mean that the overhead productivity ratios between the sampled companies differ. Above inter-company hypothesis will be tested with the help of Kruskal Wallis One Way Analysis of Variance Test.

6.2.4. Computation of Possible Savings

- The possible savings in overhead input can be calculated on the basis of following formula:

  Possible saving in overhead input = Actual overhead input – Standard overhead input

- Standard overhead input = minimum requirement of overhead input per ₹ of output X Actual Output revalued according to the base year.
- Actual overhead input means the actual revalued overhead input according to base year prices.

6.3. Overhead Productivity

Overhead productivity of six sectors included in Nifty 50 has been calculated and analysis has been drawn out of it. These six sectors include Automobile, Energy, Information Technology, Metals, Pharmaceutical and Refineries. It also elaborate the Power and Fuel Input Output Ratio, Depreciation and Amortisation Input Output Ratio, Repairs and Maintenance Input Output Ratio, Business Service Input Output Ratio, Total Overhead Input Output ratio, Overhead Productivity Ratio, Overhead Productivity Indices or Observed values (O) and Expected Values (E) and lastly the chi-square test for testing the hypothesis. Each has been explained below:

6.3.1. Overhead Productivity of Automobile Sector Companies

Overhead productivity of automobile sector companies has been displayed from table 6.1 to 6.4. It portrays the overhead productivity ratios from 2010-11 to 2017-18 taking 2010-11 as a base year for revaluation of output and input.

Table 6.1

Overhead Productivity of Bajaj Auto Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	16891.95	18399.35	17881.58	17003.01	17842.32	19807.03	18883.71	21190.96
2	Power and Fuel (₹ in Crore)	86.61	89.42	99.37	81.21	93.48	122.35	98.10	94.34
3	Power and Fuel (Input Output Ratio)	0.0051	0.0049	0.0056	0.0048	0.0052	0.0062	0.0052	0.0045
4	Depreciation and Amortisation (₹ in Crore)	122.84	145.62	166.77	179.61	267.40	307.16	307.29	314.80
5	Depreciation and Amortisation (Input Output Ratio)	0.0073	0.0079	0.0093	0.0106	0.0150	0.0155	0.0163	0.0149
6	Repairs and Maintenance (₹ in Crore)	79.67	94.27	112.22	118.05	160.98	169.92	154.77	130.44
7	Repairs and Maintenance (Input Output Ratio)	0.0047	0.0051	0.0063	0.0069	0.0090	0.0086	0.0082	0.0062
8	Business Service Input (₹ in Crore)	474.55	530.83	585.77	649.58	797.49	977.52	888.11	1000.27
9	Business Service Input (Input Output Ratio)	0.0281	0.0289	0.0328	0.0382	0.0447	0.0494	0.0470	0.0472
10	Total Overhead Input (₹ in Crore)	763.67	860.15	964.13	1028.46	1319.35	1576.95	1448.27	1539.86
11	Overhead (Input Output Ratio)	0.0452	0.0467	0.0539	0.0605	0.0739	0.0796	0.0767	0.0727
12	Overhead Productivity Ratio	22.1194	21.3909	18.5469	16.5325	13.5236	12.5603	13.0388	13.7616
13	Overhead Productivity Indices /Observed Indices (O)	100.00	96.71	83.85	74.74	61.14	56.78	58.95	62.22
14	Computed Value /Expected Values (E)	97.13	90.61	84.09	77.56	71.04	64.51	57.99	51.46
15	Chi-Square $(O-E)^2/E$	0.0845	0.4102	0.0007	0.1024	1.3788	0.9254	0.0159	2.2474

Average Overhead Productivity Indices =74.30, a = 74.30, b = -3.26, χ^2 = 5.165, S.D. = 16.26, C.V. = 21.89%

Analysis and Interpretation

Output: The revalued output of Bajaj Auto Ltd. is portraying an erratic trend. It is the highest ₹ 21190.96 crore in 2017-18 and it is the lowest ₹ 16891.95 crore in 2010-11.

Power and Fuel: It is ₹ 86.61 crore in 2010-11, ₹ 89.42 crore in 2011-12, ₹ 99.37 crore in 2012-13, ₹ 81.21 crore in 2013-14, ₹ 93.48 crore in 2014-15, ₹ 122.35 crore in 2015-16, ₹ 98.10 crore in 2016-17 and ₹ 94.34 crore in 2017-18. Power and fuel input output ratio is the highest 0.0062 in 2015-16 while it is the lowest 0.0045 in 2017-18.

Depreciation and Amortisation: It is highlighting an increasing trend. It is the highest ₹ 314.80 crore in 2017-18 while it is the lowest ₹ 122.84 crore in 2010-11. Input output ratio of depreciation and amortization is the lowest 0.0073 in 2010-11 as compared to the highest 0.0163 in 2016-17.

Repairs and Maintenance: It is the highest ₹ 169.92 crore in 2015-16 as compared to the lowest ₹ 79.67 crore in 2010-11. Input output ratio is the lowest 0.0047 in 2010-11 while it is the highest 0.0090 in 2014-15

Business Service Input: It is ₹ 474.55 crore in 2010-11, ₹ 530.83 crore in 2011-12, ₹ 585.77 crore in 2012-13, ₹ 649.58 crore in 2013-14, ₹ 797.49 crore in 2014-15, ₹ 977.52 crore in 2015-16, ₹ 888.11 crore in 2016-17 and ₹ 1000.27 crore in 2017-18. Input output ratio is the highest 0.0494 in 2015-16 as compared to the lowest 0.0281 in 2010-11.

Total Overhead: Total overhead input is ₹ 763.67 crore in 2010-11, ₹ 860.15 crore in 2011-12, ₹ 964.13 crore in 2012-13, ₹ 1028.46 crore in 2013-14, ₹ 1319.35 crore in 2014-15, ₹ 1576.95 crore in 2015-16, ₹ 1448.27 crore in 2016-17 and ₹ 1539.86 crore in 2017-18. Total overhead input output ratio is the highest 0.0796 in 2015-16 while it is the lowest 0.0452 in 2010-11.

Overhead Productivity Ratio: There is a decreasing trend in the overhead productivity ratio of Bajaj Auto Ltd. except in the year 2016-17 and 2017-18. Overhead productivity ratio is 22.1194 in 2010-11 and reached to 12.5603 in 2015-16 while it is 13.0388 in 2016-17 and 13.7616 in 2017-18. Overhead productivity ratio is the lowest 12.5603 in 2015-16 while it is the highest 22.1194 in 2010-11. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overhead input has not been utilized efficiently. Overhead efficiency can also be observed from the average of overhead indices which worked out as 74.30 as compared to the base year index of 100 indicates less efficiency.

Testing Hypothesis and Interpretation: In Bajaj Auto Ltd. the standard deviation calculated is 16.26 and coefficient of variation is 21.89 % which conveys the variability in the data. The computed value of chi-square is 5.165. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the overhead productivity indices of the company for the study period are approximately equal and can be represented by straight line trend or line of best fit.

Table 6.2

Overhead Productivity of Mahindra & Mahindra Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	23692.18	29120.78	35143.67	33416.69	31931.62	34755.61	37410.97	39883.51
2	Power and Fuel (₹ in Crore)	143.93	154.33	169.03	169.33	181.26	233.87	234.25	232.55
3	Power and Fuel (Input Output Ratio)	0.0061	0.0053	0.0048	0.0051	0.0057	0.0067	0.0063	0.0058
4	Depreciation and Amortisation (₹ in Crore)	413.86	576.14	710.81	863.34	974.90	1108.61	1526.38	1479.42
5	Depreciation and Amortisation (Input Output Ratio)	0.0175	0.0198	0.0202	0.0258	0.0305	0.0319	0.0408	0.0371
6	Repairs and Maintenance (₹ in Crore)	161.66	198.02	210.24	233.89	246.28	299.93	288.74	310.93
7	Repairs and Maintenance (Input Output Ratio)	0.0068	0.0068	0.0060	0.0070	0.0077	0.0086	0.0077	0.0078
8	Business Service Input (₹ in Crore)	1866.17	2137.03	2419.83	2856.67	2652.73	3066.74	3292.66	3731.11
9	Business Service Input (Input Output Ratio)	0.0788	0.0734	0.0689	0.0855	0.0831	0.0882	0.0880	0.0936
10	Total Overhead Input (₹ in Crore)	2585.62	3065.53	3509.91	4123.23	4055.18	4709.15	5342.03	5754.01
11	Total Overhead (Input Output Ratio)	0.1091	0.1053	0.0999	0.1234	0.1270	0.1355	0.1428	0.1443
12	Overhead Productivity Ratio	9.1631	9.4994	10.0127	8.1045	7.8743	7.3804	7.0031	6.9314
13	Overhead Productivity Indices /Observed Indices (O)	100.00	103.67	109.27	88.45	85.94	80.55	76.43	75.65
14	Computed Value /Expected Values (E)	106.47	101.76	97.05	92.35	87.64	82.93	78.23	73.52
15	Chi-Square $(O-E)^2/E$	0.3929	0.0359	1.5383	0.1646	0.0332	0.0687	0.0413	0.0615

Average Overhead Productivity Indices =89.99, a= 89.99, b = -2.35, χ^2 = 2.336, S.D. = 12.03, C.V. = 13.36 %

Analysis and Interpretation

Output: The revalued output of Mahindra & Mahindra Ltd. is ₹ 23692.18 crore in 2010-11, ₹ 29120.78 crore in 2011-12, ₹ 35143.67 crore in 2012-13, ₹ 33416.69 crore in 2013-14, ₹ 31931.62 crore in 2014-15, ₹ 34755.61 crore in 2015-16, ₹ 37410.97 crore in 2016-17, ₹ 39883.51 crore in 2017-18.

Power and Fuel: Its consumption is increasing year by year except in 2017-18. It is the highest ₹ 234.25 crore in 2016-17 and the lowest ₹ 143.93 crore in 2010-11. Its input output ratio is the highest 0.0067 in 2015-16 while it is the lowest 0.0048 in 2012-13.

Depreciation and Amortisation: It is the highest ₹ 1526.38 crore in 2016-17 while it is the lowest ₹ 413.86 crore in 2010-11. Input output ratio of depreciation and amortisation is the lowest 0.0175 in 2010-11 as compared to the highest 0.0408 in 2016-17.

Repairs and Maintenance: It is the lowest ₹ 161.66 crore in 2010-11 as compared to ₹ 310.93 crore in 2017-18. Input output ratio is 0.0068 in 2010-11, 0.0068 in 2011-12, 0.0060 in 2012-13, 0.0070 in 2013-14, 0.0077 in 2014-15, 0.0086 in 2015-16, 0.0077 in 2016-17 and 0.0078 in 2017-18. It is the lowest 0.0060 in 2012-13 indicates fewer amounts have been expended on repairs and maintenance.

Business Service Input: It is ₹ 1866.17 crore in 2010-11, ₹ 2137.03 crore in 2011-12, ₹ 2419.83 crore in 2012-13, ₹ 2856.67 crore in 2013-14, ₹ 2652.73 crore in 2014-15, ₹ 3066.74 crore in 2015-16, ₹ 3292.66 crore in 2016-17 and ₹ 3731.11 crore in 2017-18. Input output ratio of business service input is the highest 0.0936 in 2017-18 while it is the lowest 0.0689 in 2012-13.

Total Overhead: Total overhead input is unveiling an increasing trend except in the year 2014-15. It is ₹ 2585.62 crore in 2010-11, ₹ 3065.53 crore in 2011-12, ₹ 3509.91 crore in 2012-13, ₹ 4123.23 crore in 2013-14, then it is slightly decreased to ₹ 4055.18 crore in 2014-15, then again it started increasing to ₹ 4709.15 crore in 2015-16, ₹ 5342.03 crore in 2016-17 and ₹ 5754.01 crore in 2017-18. Total overhead input output ratio is the highest 0.1443 in 2017-18 while it is the lowest 0.0999 in 2012-13.

Overhead Productivity Ratio: Overhead productivity ratio is 9.1631 in 2010-11, 9.4994 in 2011-12, 10.0127 in 2012-13, 8.1045 in 2013-14, 7.8743 in 2014-15, 7.3804 in 2015-16, 7.0031 in 2016-17 and 6.9314 in 2017-18. Overhead productivity ratio is the lowest 6.9314 in 2017-18 while it is the highest 10.0127 in 2012-13. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overhead input has not been utilized efficiently. Overhead efficiency can also be observed from the average of overhead indices which worked out as 89.99 as compared to the base year index of 100. This indicates that overhead has not been utilized efficiently as compared to the base year.

Testing Hypothesis and Interpretation: The standard deviation worked out is 12.03 and its coefficient of variation is 13.36 %. The computed value of chi-square of Mahindra & Mahindra Ltd. is 2.336. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the overhead productivity ratios of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 6.3

Overhead Productivity of Maruti Suzuki India Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	37071.20	33307.52	38159.96	36346.27	40579.12	48726.04	57572.80	65397.27
2	Power and Fuel (₹ in Crore)	210.20	201.50	404.34	454.49	580.52	702.30	525.99	632.26
3	Power and Fuel (Input Output Ratio)	0.0057	0.0060	0.0106	0.0125	0.0143	0.0144	0.0091	0.0097
4	Depreciation and Amortisation (₹ in Crore)	1013.50	1138.40	1861.20	2084.40	2470.30	2823.90	2602.10	2757.90
5	Depreciation and Amortisation (Input Output Ratio)	0.0273	0.0342	0.0488	0.0573	0.0609	0.0580	0.0452	0.0422
6	Repairs and Maintenance (₹ in Crore)	84.80	82.99	128.08	148.43	155.64	228.58	215.54	259.44
7	Repairs and Maintenance (Input Output Ratio)	0.0023	0.0025	0.0034	0.0041	0.0038	0.0047	0.0037	0.0040
8	Business Service Input (₹ in Crore)	3547.20	3406.70	4209.53	4036.83	4423.73	5657.45	6269.04	6919.02
9	Business Service Input (Input Output Ratio)	0.0957	0.1023	0.1103	0.1111	0.1090	0.1161	0.1089	0.1058
10	Total Overhead Input (₹ in Crore)	4855.70	4829.59	6603.15	6724.15	7630.19	9412.23	9612.67	10568.61
11	Overhead (Input Output Ratio)	0.1310	0.1450	0.1730	0.1850	0.1880	0.1932	0.1670	0.1616
12	Overhead Productivity Ratio	7.6346	6.8966	5.7791	5.4053	5.3182	5.1769	5.9893	6.1879
13	Overhead Productivity Indices /Observed Indices (O)	100.00	90.33	75.70	70.80	69.66	67.81	78.45	81.05
14	Computed Value /Expected Values (E)	88.26	85.68	83.10	80.52	77.93	75.35	72.77	70.19
15	Chi-Square $(O-E)^2/E$	1.5613	0.2528	0.6593	1.1722	0.8784	0.7552	0.4432	1.6810

Average Overhead Productivity Indices=79.22, a=79.22, b = -1.29, χ^2 = 7.403, S.D. = 10.39, C.V. = 13.12 %

Analysis and Interpretation

Output: The output of Maruti Suzuki India Ltd. is manifesting a choppy trend. It is the highest ₹ 65397.27 crore in 2017-18 and it is the lowest ₹ 33307.52 crore in 2011-12.

Power and Fuel: The important part to analyse in overhead input is power and fuel. It is displaying an erratic trend with ₹ 210.20 crore in 2010-11, then it is decreased and reached to ₹ 201.50 crore in 2011-12, then it is increased to ₹ 404.34 crore in 2012-13, then again it increased to ₹ 454.49 crore in 2013-14, ₹ 580.52 crore in 2014-15, ₹ 720.30 crore in 2015-16, ₹ 525.99 crore in 2016-17 and ₹ 632.26 crore on 2017-18. It is the highest ₹ 702.30 crore in 2015-16 while it is the lowest ₹ 201.50 crore in 2011-12. Its input output ratio is the highest 0.0144 in 2015-16 while it is the lowest 0.0057 in 2010-11.

Depreciation and Amortisation: It is the highest ₹ 2823.90 crore in 2015-16 while it is the lowest ₹ 1013.50 crore in 2010-11. Input output ratio is the lowest 0.0273 in 2010-11 as compared to the highest 0.0609 in 2014-15.

Repairs and Maintenance: It is the highest ₹ 259.44 crore in 2017-18 while it is the lowest ₹ 82.99 crore in 2011-12. Input output ratio is the lowest 0.0023 in 2010-11 and it is the highest 0.0047 in 2015-16.

Business Service Input: It is the lowest ₹ 3406.70 crore in 2011-12 as compared to the highest ₹ 6919.02 crore in 2017-18. Its input output ratio is the lowest 0.0957 in 2010-11 as compared to the highest 0.1161 in 2015-16.

Total Overhead: Total overhead input of Maruti Suzuki India Ltd. is portraying an increasing trend except in the year 2011-12 this means that expenses on overhead has increased on year to year basis. It is the lowest ₹ 4829.59 crore in 2011-12 as compared to ₹ 10568.61 crore in 2017-18. Total overhead input output ratio is the highest 0.1932 in 2015-16 while it is the lowest 0.1310 in 2010-11. The lowest overhead input output ratio means overhead has been best utilized in 2010-11.

Overhead Productivity Ratio: Overhead productivity ratio of Maruti Suzuki India Ltd. is 7.6346 in 2010-11, 6.8966 in 2011-12, 5.7791 in 2012-13, 5.4053 in 2013-14, 5.3182 in 2014-15, 5.1769 in 2015-16, 5.9893 in 2016-17 and 6.1879 in 2017-18. It is the lowest 5.1769 in 2015-16 while it is the highest 7.6346 in 2010-11. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overhead input has not been utilized efficiently. Improvement in overhead efficiency can also be observed from the average of overhead indices which is 79.22 which is much lower than the base year index of 100. This indicates that the overhead has not been utilized efficiently.

Testing Hypothesis and Interpretation: The standard deviation and coefficient of variation calculated is 10.39 and 13.12 % respectively. The computed value of chi-square is 7.403. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the overhead productivity ratios of the

company for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 6.4

Overhead Productivity of Tata Motors Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	47157.19	49807.74	40124.16	31410.17	30067.20	37267.99	37072.17	48923.62
2	Power and Fuel (₹ in Crore)	471.28	483.68	396.94	299.95	322.64	407.99	491.70	512.96
3	Power and Fuel (Input Output Ratio)	0.0100	0.0097	0.0099	0.0095	0.0107	0.0109	0.0133	0.0105
4	Depreciation and Amortisation (₹ in Crore)	1360.77	1606.74	1817.62	2070.30	2603.22	2453.75	3037.12	3101.89
5	Depreciation and Amortisation (Input Output Ratio)	0.0289	0.0323	0.0453	0.0659	0.0866	0.0658	0.0819	0.0634
6	Repairs and Maintenance (₹ in Crore)	128.25	161.18	161.13	116.95	134.45	131.83	0.00	0.00
7	Repairs and Maintenance (Input Output Ratio)	0.0027	0.0032	0.0040	0.0037	0.0045	0.0035	-	-
8	Business Service Input (₹ in Crore)	4836.92	5740.38	5091.61	4385.06	5155.14	5358.01	5523.72	6128.09
9	Business Service Input (Input Output Ratio)	0.1026	0.1153	0.1269	0.1396	0.1715	0.1438	0.1490	0.1253
10	Total Overhead Input (₹ in Crore)	6797.22	7991.99	7467.30	6872.26	8215.45	8351.58	9052.54	9742.94
11	Total Overhead (Input Output Ratio)	0.1441	0.1605	0.1861	0.2188	0.2732	0.2241	0.2442	0.1991
12	Overhead Productivity Ratio	6.9377	6.2322	5.3733	4.5706	3.6598	4.4624	4.0952	5.0214
13	Overhead Productivity Indices /Observed Indices (O)	100.00	89.83	77.45	65.88	52.75	64.32	59.03	72.38
14	Computed Value /Expected Values (E)	89.37	84.61	79.85	75.09	70.33	65.56	60.80	56.04
15	Chi-Square $(O-E)^2/E$	1.2652	0.3226	0.0719	1.1286	4.3908	0.0236	0.0519	4.7612

Average Overhead Productivity Indices= 72.71, a= 72.71, b=-2.38, χ^2 = 12.016, S.D. = 14.84, C.V. = 20.42 %

Analysis and Interpretation

Output: The revalued output of Tata Motors Ltd. the highest ₹ 49807.74 crore in 2011-12 while it is the lowest in ₹ 30067.20 crore in 2014-15.

Power and Fuel: It is the highest ₹ 512.96 crore in 2017-18 and the lowest ₹ 299.95 crore in 2013-14. Its input output ratio is 0.0100 in 2010-11, 0.0097 in 2011-12, 0.0099 in 2012-13, 0.0095 in 2013-14, 0.0107 in 2014-15, 0.0109 in 2015-16, 0.0133 in 2016-17 and 0.0105 in 2017-18. It is the highest 0.0133 in 2016-17 while it is the lowest 0.0095 in 2013-14.

Depreciation and Amortisation: It is the highest ₹ 3101.89 crore in 2017-18 while it is the lowest ₹ 1360.77 crore in 2010-11. Input output ratio is the lowest 0.0289 in 2010-11 as compared to the highest 0.0866 in 2014-15.

Repairs and Maintenance: It is the lowest ₹ 116.95 crore in 2013-14 as compared to ₹ 161.18 crore in 2011-12 which is the highest. Repair and maintenance for the year 2016-17 and 2017-18 is not known has ignored. Input output ratio is the lowest 0.0027 in 2010-11 and the highest 0.0045 in 2014-15.

Business Service Input: It is the highest ₹ 6128.09 crore in 2017-18 while it is the lowest ₹ 4385.06 crore in 2013-14.

Total Overhead: Total overhead input is ₹ 6797.22 crore in 2010-11, then it is increased to ₹ 7991.99 crore in 2011-12, then it is decreased to ₹ 7467.30 crore in

2012-13, then again it decreased to ₹ 6872.26 crore in 2013-14, then it increased to ₹ 8215.45 crore in 2014-15, again increased to ₹ 8351.58 crore in 2015-16, then it is ₹ 9052.54 crore in 2016-17 and lastly it reached to ₹ 9742.94 crore in 2017-18. Total overhead input output ratio is the highest 0.2732 in 2014-15 while it is the lowest 0.1441 in 2010-11. The lowest overhead input output ratio means total overhead is best utilized in the year 2010-11 as compared to other years under study of Tata Motors Ltd.

Overhead Productivity Ratio: The standard deviation of Tata Motors Ltd. is 14.84 and its coefficient of variation is 20.42%.Overhead productivity ratio is 6.9377 in 2010-11, 6.2322 in 2011-12, 5.3733 in 2012-13, 4.5706 in 2013-14, 3.6598 in 2014-15, 4.4624 in 2015-16, 4.0952 in 2016-17 and 5.0214 in 2017-18. Overhead productivity ratio is the lowest 3.6598 in 2014-15 while it is the highest 6.9377 in 2010-11. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overhead input has not been utilized efficiently. Overhead efficiency can also be analysed from the average of overhead indices. It is 72.71 which is less than the base year index of 100. This indicates that on an average overhead is not utilized efficiently.

Testing Hypothesis and Interpretation: The chi-square value of Tata Motors Ltd. is 12.016. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the overhead productivity ratios of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

6.3.2. Overhead Productivity of Energy Sector Companies

Overhead productivity of energy sector companies has been illustrated from table 6.5 to 6.8 from 2010-11 to 2017-18 taking 2010-11 as a base year for revaluation.

Table 6.5

Overhead Productivity of GAIL (India) Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	32844.73	37024.85	41429.76	47148.15	46615.02	44514.51	40629.38	43636.95
2	Power and Fuel (₹ in Crore)	972.85	935.67	1018.10	1282.41	1578.76	2059.95	1940.86	2011.66
3	Power and Fuel (Input Output Ratio)	0.0296	0.0253	0.0246	0.0272	0.0339	0.0463	0.0478	0.0461
4	Depreciation and Amortisation (₹ in Crore)	650.25	790.71	980.94	1176.15	974.26	1313.09	1396.78	1415.14
5	Depreciation and Amortisation (Input Output Ratio)	0.0198	0.0214	0.0237	0.0249	0.0209	0.0295	0.0344	0.0324
6	Repairs and Maintenance (₹ in Crore)	206.70	229.76	255.07	283.52	396.15	409.69	359.88	305.13
7	Repairs and Maintenance (Input Output Ratio)	0.0063	0.0062	0.0062	0.0060	0.0085	0.0092	0.0089	0.0070
8	Business Service Input (₹ in Crore)	1241.70	1794.01	1822.84	1745.15	2296.80	1361.18	1151.84	1117.93
9	Business Service Input (Input Output Ratio)	0.0378	0.0485	0.0440	0.0370	0.0493	0.0306	0.0283	0.0256
10	Total Overhead Input (₹ in Crore)	3071.50	3750.14	4076.95	4487.22	5245.97	5143.92	4849.36	4849.86
11	Total Overhead (Input Output Ratio)	0.0935	0.1013	0.0984	0.0952	0.1125	0.1156	0.1194	0.1111
12	Overhead Productivity Ratio	10.6934	9.8729	10.1619	10.5072	8.8859	8.6538	8.3783	8.9976
13	Overhead Productivity Indices /Observed Indices (O)	100.00	92.33	95.03	98.26	83.10	80.93	78.35	84.14
14	Computed Value /Expected Values (E)	98.95	96.11	93.27	90.44	87.60	84.76	81.92	79.08
15	Chi-Square $(O-E)^2/E$	0.0112	0.1489	0.0331	0.6768	0.2312	0.1733	0.1557	0.3234

Average Overhead Productivity Indices = 89.02, a = 89.02, b = - 1.42, χ^2 = 1.754, S.D. = 7.84, C.V. = 8.80 %

Analysis and Interpretation

Output: The revalued output of GAIL (India) Ltd. is ₹ 32844.73 crore in 2010-11 and reached to ₹ 43636.95 crore in 2017-18.

Power and Fuel: The most important chunk of overhead input is power and fuel. It is the lowest ₹ 935.67 crore in 2011-12 and compared to the highest ₹ 2059.95 crore in 2015-16. Its input output ratio is very important to calculate as this represents that for one ₹ of output, how much input is required. Its input output ratio is the highest 0.0478 in 2016-17 while it is the lowest 0.0246 in 2012-13.

Depreciation and Amortisation: Depreciation and amortisation factor of overhead input is the highest ₹ 1415.14 crore in 2017-18 while it is the lowest ₹ 650.25 crore in 2010-11. Input output ratio of depreciation and amortisation is the lowest 0.0198 in 2010-11 as compared to the highest 0.0344 in 2016-17.

Repairs and Maintenance: It is ₹ 206.70 crore in 2010-11, ₹ 229.76 crore in 2011-12, ₹ 255.07 crore in 2012-13, ₹ 283.52 crore in 2013-14, ₹ 396.15 crore in 2014-15, ₹ 409.69 crore in 2015-16, ₹ 359.88 crore in 2016-17 and ₹ 305.13 crore in 2017-18. Its input output ratio is the lowest 0.0060 in 2013-14 while it is the highest 0.0092 in 2015-16.

Business Service Input: It is the lowest ₹ 1117.93 crore in 2017-18 while it is the highest ₹ 2296.80 crore in 2014-15. Its input output ratio is the lowest 0.0256 in 2017-18 while it is the highest 0.0493 in 2014-15.

Total Overhead: Total overhead input is ₹ 3071.50 crore in 2010-11, increased and reached to ₹ 5245.97 crore in 2014-15 then it slightly decreased and reached to ₹ 4849.36 crore in 2016-17 and ultimately reached to ₹ 4849.86 crore in 2017-18. Total overhead input output ratio is the highest 0.1194 in 2016-17 while it is the lowest 0.0935 in 2010-11.

Overhead Productivity Ratio: Overhead productivity ratio is 10.6934 in 2010-11, 9.8729 in 2011-12, 10.1619 in 2012-13, 10.5072 in 2013-14, 8.8859 in 2014-15, 8.6538 in 2015-16, 8.3783 in 2016-17 and 8.9976 in 2017-18. Overhead productivity ratio is the lowest 8.3783 in 2016-17 while it is the highest 10.6934 in 2010-11. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overhead input has not been utilized efficiently as compared to the other year but in this case it is greater than one indicates more output from less input. Overhead efficiency can also be analysed from the average of overhead indices which worked out to 89.02 as compared to the base year index of 100 of 2010-11.

Testing Hypothesis and Interpretation: The standard deviation and coefficient of variation of GAIL (India) Ltd. is 7.84 and 8.80 % respectively. The computed value of chi-square is 1.754. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence, null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the overhead productivity indices of GAIL (India) Ltd. for the study period are approximately equal and can be represented by straight line trend or line of best fit.

Table 6.6

Overhead Productivity of NTPC Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	57407.30	59514.54	59078.16	60961.58	60721.91	60009.61	65298.71	68081.15
2	Power and Fuel (₹ in Crore)	422.59	470.77	526.69	520.64	534.37	725.19	777.50	1081.94
3	Power and Fuel (Input Output Ratio)	0.0074	0.0079	0.0089	0.0085	0.0088	0.0121	0.0119	0.0159
4	Depreciation and Amortisation (₹ in Crore)	2485.69	2791.70	3396.76	4142.19	4911.65	5425.32	5920.82	7098.86
5	Depreciation and Amortisation (Input Output Ratio)	0.0433	0.0469	0.0575	0.0679	0.0809	0.0904	0.0907	0.1043
6	Repairs and Maintenance (₹ in Crore)	1495.48	1623.86	1677.94	1768.58	1903.10	2152.37	1900.89	2201.22
7	Repairs and Maintenance (Input Output Ratio)	0.0261	0.0273	0.0284	0.0290	0.0313	0.0359	0.0291	0.0323
8	Business Service Input (₹ in Crore)	2976.88	1136.90	1347.27	1345.00	1487.96	2047.96	1613.65	2751.25
9	Business Service Input (Input Output Ratio)	0.0519	0.0191	0.0228	0.0221	0.0245	0.0341	0.0247	0.0404
10	Total Overhead Input (₹ in Crore)	7380.64	6023.23	6948.66	7776.42	8837.08	10350.85	10212.86	13133.28
11	Total Overhead (Input Output Ratio)	0.1286	0.1012	0.1176	0.1276	0.1455	0.1725	0.1564	0.1929
12	Overhead Productivity Ratio	7.7781	9.8808	8.5021	7.8393	6.8713	5.7976	6.3938	5.1839
13	Overhead Productivity Indices /Observed Indices (O)	100.00	127.03	109.31	100.79	88.34	74.54	82.20	66.65
14	Computed Value /Expected Values (E)	117.54	110.70	103.86	97.03	90.19	83.35	76.51	69.67
15	Chi-Square $(O-E)^2/E$	2.6174	2.4095	0.2854	0.1458	0.0378	0.9319	0.4232	0.1315

Average Overhead Productivity Indices= 93.61, a= 93.61, b = -3.42, χ^2 = 6.982, S.D. = 18.39, C.V. = 19.64 %

Analysis and Interpretation

Output: The revalued output of NTPC Ltd. is ₹ 57407.30 crore in 2010-11 and reached to ₹ 68081.15 crore in 2017-18.

Power and Fuel: Power and fuel share of overhead input is the highest ₹ 1081.94 crore in 2017-18 and the lowest ₹ 422.59 crore in 2010-11. Its input output ratio is the highest 0.0159 in 2017-18 while it is the lowest 0.0074 in 2010-11.

Depreciation and Amortisation: It is the highest ₹ 7098.86 crore in 2017-18 while it is the lowest ₹ 2485.69 crore in 2010-11. Its input output ratio is the lowest 0.0433 in 2010-11 as compared to the highest 0.1043 in 2017-18.

Repairs and Maintenance: It is ₹ 1495.48 crore in 2010-11 and reached to ₹ 2201.22 crore in 2017-18. Its input output ratio is 0.0261 in 2010-11, 0.0273 in 2011-12, 0.0284 in 2012-13, 0.0290 in 2013-14, 0.0313 in 2014-15, 0.0359 in 2015-16, 0.0291 in 2016-17 and 0.0323 in 2017-18. It is the lowest 0.0261 in 2010-11 and the highest 0.0359 in 2015-16.

Business Service Input: Business service input is the highest ₹ 2976.88 crore in 2010-11 and it is the lowest ₹ 1136.90 crore in 2011-12. Its input output ratio is the highest 0.0519 in 2010-11 and it is the lowest 0.0191 in 2011-12.

Total Overhead: Total overhead input is ₹ 7380.64 crore in 2010-11, ₹ 6023.23 crore in 2011-12, ₹ 6948.66 crore in 2012-13, ₹ 7776.42 crore in 2013-14, ₹ 8837.08 crore in 2014-15, ₹ 10350.85 crore in 2015-16, ₹ 10212.86 crore in 2016-

17 and ₹ 13133.28 crore in 2017-18. Total overhead input output ratio is the highest 0.1929 in 2017-18 while it is the lowest 0.1012 in 2011-12.

Overhead Productivity Ratio: Overhead productivity ratio is 7.7781 in 2010-11 and reached to 5.1839 in 2017-18. Overhead productivity ratio is the lowest 5.1839 in 2017-18 while it is the highest 9.8808 in 2011-12. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overhead input has not been utilized efficiently as compared to other years. Overhead efficiency can also be observed from the average of overhead indices which worked out as 93.61.

Testing Hypothesis and Interpretation: The standard deviation is 18.39 with coefficient of variation 19.64 % indicated the variability. The computed value of chi-square is 6.982. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the overhead productivity indices of the NTPC Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 6.7

Overhead Productivity of Oil and Natural Gas Corporation Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	71732.86	74244.84	75951.96	74017.52	70984.50	70792.55	70326.36	74166.87
2	Power and Fuel (₹ in Crore)	285.60	277.61	274.33	291.29	317.95	519.04	568.10	470.88
3	Power and Fuel (Input Output Ratio)	0.0040	0.0037	0.0036	0.0039	0.0045	0.0073	0.0081	0.0063
4	Depreciation and Amortisation (₹ in Crore)	15925.65	16829.35	18416.67	18761.57	21980.77	17287.19	17243.99	21501.98
5	Depreciation and Amortisation (Input Output Ratio)	0.2220	0.2267	0.2425	0.2535	0.3097	0.2442	0.2452	0.2899
6	Repairs and Maintenance (₹ in Crore)	886.78	642.72	760.77	724.12	843.03	1226.67	1052.72	930.18
7	Repairs and Maintenance (Input Output Ratio)	0.0124	0.0087	0.0100	0.0098	0.0119	0.0173	0.0150	0.0125
8	Business Service Input (₹ in Crore)	17464.04	18763.39	20335.42	18567.64	19714.15	20695.14	18562.18	17886.61
9	Business Service Input (Input Output Ratio)	0.2435	0.2527	0.2677	0.2509	0.2777	0.2923	0.2639	0.2412
10	Total Overhead Input (₹ in Crore)	34562.07	36513.06	39787.20	38344.62	42855.89	39728.04	37426.99	40789.64
11	Total Overhead (Input Output Ratio)	0.4818	0.4918	0.5238	0.5180	0.6037	0.5612	0.5322	0.5500
12	Overhead Productivity Ratio	2.0755	2.0334	1.9090	1.9303	1.6564	1.7819	1.8790	1.8183
13	Overhead Productivity Indices /Observed Indices (O)	100.00	97.97	91.98	93.01	79.81	85.86	90.53	87.61
14	Computed Value /Expected Values (E)	97.32	95.47	93.62	91.77	89.92	88.07	86.22	84.37
15	Chi-Square $(O-E)^2/E$	0.0736	0.0654	0.0289	0.0166	1.1375	0.0556	0.2162	0.1246

Average Overhead Productivity Indices = 90.84, a = 90.84, b = - 0.93, χ^2 = 1.718, S.D. = 6.10, C.V. = 6.72 %

Analysis and Interpretation

Output: The output of Oil and Natural Gas Corporation Ltd. range between ₹ 70326.36 crore and ₹ 75951.96 crore.

Power and Fuel: It displays the fluctuating trend with ₹ 285.60 crore in 2010-11 and reached to ₹ 470.88 crore in 2017-18. It is the highest ₹ 568.10 crore in 2016-17 while it is the lowest ₹ 274.33 crore in 2012-13. Its input output ratio is the highest 0.0081 in 2016-17 while it is the lowest 0.0036 in 2012-13.

Depreciation and Amortisation: It is the highest ₹ 21980.77 crore in 2014-15 while it is the lowest ₹ 15925.65 crore in 2010-11. Input output ratio of depreciation and amortisation is the lowest 0.2220 in 2010-11 as compared to the highest 0.3097 in 2014-15.

Repairs and Maintenance: Repairs and maintenance is the highest ₹ 1226.67 crore in 2015-16 while it is the lowest ₹ 642.72 crore in 2011-12. Its input output ratio is the lowest 0.0087 in 2011-12 and it is the highest 0.0173 in 2015-16.

Business Service Input: It is ₹ 17464.04 crore in 2010-11 and reached to ₹ 17886.61 crore in 2017-18. Its input output ratio is 0.2435 in 2010-11 and reached to 0.2412 in 2017-18.

Total Overhead: Total overhead input is the lowest ₹ 34562.07 crore in 2010-11 as compared to the highest ₹ 42855.89 crore in 2014-15. Total overhead input output ratio is the highest 0.6037 in 2014-15 while it is the lowest 0.4818 in 2010-11. The lowest overhead input output ratio means overhead has been best utilized in 2010-11.

Overhead Productivity Ratio: Overhead productivity ratio of Oil and Natural Gas Corporation Ltd. is 2.0755 in 2010-11, 2.0334 in 2011-12, 1.9090 in 2012-13, 1.9303 in 2013-14, 1.6564 in 2014-15, 1.7819 in 2015-16, 1.8790 in 2016-17 and 1.8183 in 2017-18. The highest ratio 2.0755 in 2010-11 indicates efficiency and effectiveness while the lowest ratio 1.6564 in 2014-15 indicates that the overhead input has not been utilized efficiently. The average of overhead indices worked out as 90.84 which is lower than the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation and coefficient of variation of Oil and Natural Gas Corporation Ltd. is 6.10 and 6.72 % respectively. The computed value of chi-square is 1.718. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the

overhead productivity ratios of the company for the study period of eight years are approximately same and can be represented by straight line trend or line of best fit.

Table 6.8

Overhead Productivity of Power Grid Corporation of India Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	9098.75	9900.64	11449.39	12828.67	14330.71	17812.35	21872.62	24582.29
2	Power and Fuel (₹ in Crore)	72.21	70.87	86.76	93.46	138.53	162.78	231.74	229.40
3	Power and Fuel (Input Output Ratio)	0.0079	0.0072	0.0076	0.0073	0.0097	0.0091	0.0106	0.0093
4	Depreciation and Amortisation (₹ in Crore)	2199.39	2572.54	3351.92	3995.68	5085.41	6182.76	7662.80	9091.25
5	Depreciation and Amortisation (Input Output Ratio)	0.2417	0.2598	0.2928	0.3115	0.3549	0.3471	0.3503	0.3698
6	Repairs and Maintenance (₹ in Crore)	188.35	198.73	218.98	267.71	340.16	399.01	469.64	495.90
7	Repairs and Maintenance (Input Output Ratio)	0.0207	0.0201	0.0191	0.0209	0.0237	0.0224	0.0215	0.0202
8	Business Service Input (₹ in Crore)	438.34	470.69	438.60	540.65	614.27	752.50	765.95	1067.30
9	Business Service Input (Input Output Ratio)	0.0482	0.0475	0.0383	0.0421	0.0429	0.0422	0.0350	0.0434
10	Total Overhead Input (₹ in Crore)	2898.29	3312.83	4096.26	4897.49	6178.38	7497.04	9130.13	10883.85
11	Total Overhead (Input Output Ratio)	0.3185	0.3346	0.3578	0.3818	0.4311	0.4209	0.4174	0.4428
12	Overhead Productivity Ratio	3.1394	2.9886	2.7951	2.6194	2.3195	2.3759	2.3957	2.2586
13	Overhead Productivity Indices /Observed Indices (O)	100.00	95.20	89.03	83.44	73.88	75.68	76.31	71.94
14	Computed Value /Expected Values (E)	97.37	93.32	89.27	85.21	81.16	77.11	73.05	69.00
15	Chi-Square $(O-E)^2/E$	0.0710	0.0378	0.0006	0.0369	0.6522	0.0264	0.1451	0.1255

Average Overhead Productivity Indices = 83.19, a = 83.19, b = -2.03, χ^2 = 1.096, S.D. = 9.86, C.V. = 11.85 %

Analysis and Interpretation

Output: The output of Power Grid Corporation of India Ltd. is showing an increasing trend with ₹ 9098.75 crore in 2010-11 and reached to ₹ 24582.29 crore in 2017-18.

Power and Fuel: It highlights a fluctuating trend. It is the maximum ₹ 231.74 crore in 2016-17 as compared to the minimum ₹ 70.87 crore in 2011-12. Its input output ratio is the maximum 0.0106 in 2016-17 while it is the minimum 0.0072 in 2011-12.

Depreciation and Amortisation: It exhibits an increasing trend from ₹ 2199.39 crore in 2010-11 to ₹ 9091.25 crore in 2017-18. Input output ratio of depreciation and amortisation is the lowest 0.2417 in 2010-11 as compared to the highest 0.3698 in 2017-18.

Repairs and Maintenance: It is the highest ₹ 495.90 crore in 2017-18 while it is the lowest ₹ 188.35 crore in 2010-11. Input output ratio is the lowest 0.0191 in 2012-13 and it is the highest 0.0237 in 2014-15.

Business Service Input: It is the highest ₹ 1067.30 crore in 2017-18 while it is the lowest ₹ 438.34 crore in 2010-11. Its input output ratio is the lowest 0.0350 in 2016-17 while it is the highest 0.0482 in 2010-11.

Total Overhead: Total overhead input is the lowest ₹ 2898.29 crore in 2010-11 as compared to the highest ₹ 10883.85 crore in 2017-18. Total overhead input output ratio is the highest 0.4428 in 2017-18 while it is the lowest 0.3185 in 2010-11. The lowest overhead input output ratio means overhead is best utilized in 2010-11.

Overhead Productivity Ratio: Overhead productivity ratio of Power Grid Corporation of India Ltd. is 3.1394 in 2010-11 and reached to 2.2586 in 2017-18. It is the lowest 2.2586 in 2017-18 while it is the highest 3.1394 in 2010-11. The highest ratio indicates efficiency and effectiveness. The average of overhead indices calculated is 83.19 which is lower than the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation and coefficient of variation of Power Grid Corporation of India Ltd. is 9.86 and 11.85 % respectively. The computed value of chi-square is 1.096 as compared to the table value of 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the overhead productivity ratios of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

6.3.3. Overhead Productivity of Information Technology Sector Companies

Overhead productivity of information technology sector companies has been calculated and displayed from table 6.9 to 6.12.

Table 6.9

Overhead Productivity of Infosys Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	26532.00	30814.51	33555.12	38284.27	40813.42	47702.30	51314.87	52702.04
2	Power and Fuel (₹ in Crore)	142.00	135.21	147.42	138.47	150.78	181.51	183.06	152.44
3	Power and Fuel (Input Output Ratio)	0.0054	0.0044	0.0044	0.0036	0.0037	0.0038	0.0036	0.0029
4	Depreciation and Amortisation (₹ in Crore)	740.00	794.00	956.00	1101.00	913.00	1115.00	1331.00	1408.00
5	Depreciation and Amortisation (Input Output Ratio)	0.0279	0.0258	0.0285	0.0288	0.0224	0.0234	0.0259	0.0267
6	Repairs and Maintenance (₹ in Crore)	265.00	284.58	292.06	323.14	427.18	630.26	883.08	720.70
7	Repairs and Maintenance (Input Output Ratio)	0.0100	0.0092	0.0087	0.0084	0.0105	0.0132	0.0172	0.0137
8	Business Service Input (₹ in Crore)	3623.00	4229.23	3901.58	4851.94	5230.94	6700.19	7093.44	7842.98
9	Business Service Input (Input Output Ratio)	0.1366	0.1372	0.1163	0.1267	0.1282	0.1405	0.1382	0.1488
10	Total Overhead Input (₹ in Crore)	4770.00	5443.02	5297.06	6414.54	6721.90	8626.95	9490.58	10124.12
11	Total Overhead (Input Output Ratio)	0.1798	0.1766	0.1579	0.1676	0.1647	0.1808	0.1849	0.1921
12	Overhead Productivity Ratio	5.5623	5.6613	6.3347	5.9684	6.0717	5.5295	5.4069	5.2056
13	Overhead Productivity Indices /Observed Indices (O)	100.00	101.78	113.89	107.30	109.16	99.41	97.21	93.59
14	Computed Value /Expected Values (E)	107.35	106.05	104.74	103.44	102.14	100.84	99.54	98.24
15	Chi-Square $(O-E)^2/E$	0.5028	0.1715	0.7981	0.1439	0.4822	0.0203	0.0546	0.2200

Average Overhead Productivity Indices= 102.79, a= 102.79, b= -0.65, χ^2 = 2.393, S.D. = 6.33, C.V. = 6.15 %.

Analysis and Interpretation

Output: The revalued output of Infosys Ltd. has an increasing trend. It range from ₹ 26532.00 crore in 2010-11 to ₹ 52702.04 crore in 2017-18.

Power and Fuel: It is ₹ 142.00 crore in 2010-11 and reached to ₹ 152.44 crore in 2017-18. Its input output ratio is the highest 0.0054 in 2010-11 while it is the lowest 0.0029 in 2017-18.

Depreciation and Amortisation: Another part of the total overhead input is depreciation and amortisation. It is the lowest ₹ 740.00 crore in 2010-11 as compared to the highest ₹ 1408.00 crore in 2017-18. Its input output ratio is the lowest 0.0224 in 2014-15 as compared to the highest 0.0288 in 2013-14.

Repairs and Maintenance: It is the minimum ₹ 265.00 crore in 2010-11 while the maximum ₹ 883.08 crore in 2016-17. Its input output ratio is the lowest 0.0084 in 2013-14 while it is the highest 0.0172 in 2016-17.

Business Service Input: Business service input lies between ₹ 3623.00 crore in 2010-11 to ₹ 7842.98 crore in 2017-18. Its input output ratio is the lowest in the year 2012-13 with 0.1163. This means that business service input is the best utilized in the year 2012-13.

Total Overhead: Total overhead input of Infosys Ltd. is ₹ 4770.00 crore in 2010-11, ₹ 5443.02 crore in 2011-12, ₹ 5297.06 crore in 2012-13, ₹ 6414.54 crore in 2013-14, ₹ 6721.90 crore in 2014-15, ₹ 8626.95 crore in 2015-16, ₹ 9490.58 crore in 2016-17 and ₹ 10124.12 crore in 2017-18. The total overhead input output ratio

is the lowest in the year 2012-13 with 0.1579 while it is the highest 0.1921 in 2017-18. This means overhead is the best utilized in the year 2012-13.

Overhead Productivity Ratio: Overhead productivity ratio is the lowest 5.2056 in 2017-18 while it is the highest 6.3347 in 2012-13. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overhead input has not been utilized efficiently. Improvement in overhead efficiency can also be observed from the average of overhead indices which worked out to 102.79 as compared to the base year index of 100 which is slightly higher than the base year.

Testing Hypothesis and Interpretation: The standard deviation of Infosys Ltd. is 6.33 with 6.15 % of variability. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square is 2.393. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This reveals that the overhead productivity indices of Infosys Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 6.10

Overhead Productivity of Tata Consultancy Services Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	29771.01	38137.37	43513.96	55314.66	62904.22	74998.91	80044.98	82424.84
2	Power and Fuel (₹ in Crore)	240.00	256.46	307.62	354.39	402.09	517.98	0.00	0.00
3	Power and Fuel (Input Output Ratio)	0.0081	0.0067	0.0071	0.0064	0.0064	0.0069	-	-
4	Depreciation and Amortisation (₹ in Crore)	537.82	688.17	802.86	1080.55	1393.77	1559.19	1575.00	1647.00
5	Depreciation and Amortisation (Input Output Ratio)	0.0181	0.0180	0.0185	0.0195	0.0222	0.0208	0.0197	0.0200
6	Repairs and Maintenance (₹ in Crore)	180.47	201.66	233.59	329.96	395.89	529.85	0.00	0.00
7	Repairs and Maintenance (Input Output Ratio)	0.0061	0.0053	0.0054	0.0060	0.0063	0.0071	-	-
8	Business Service Input (₹ in Crore)	9882.48	11794.99	14058.02	16944.50	19450.53	23153.41	12945.79	12820.75
9	Business Service Input (Input Output Ratio)	0.3319	0.3093	0.3231	0.3063	0.3092	0.3087	0.1617	0.1555
10	Total Overhead Input (₹ in Crore)	10840.77	12941.28	15402.10	18709.40	21642.28	25760.43	14520.79	14467.75
11	Total Overhead (Input Output Ratio)	0.3641	0.3393	0.3540	0.3382	0.3441	0.3435	0.1814	0.1755
12	Overhead Productivity Ratio	2.7462	2.9470	2.8252	2.9565	2.9065	2.9114	5.5124	5.6971
13	Overhead Productivity Indices /Observed Indices (O)	100.00	107.31	102.88	107.66	105.84	106.02	200.73	207.45
14	Computed Value /Expected Values (E)	78.62	93.22	107.83	122.43	137.04	151.64	166.25	180.86
15	Chi-Square $(O-E)^2/E$	5.8169	2.1293	0.2273	1.7828	7.1033	13.7293	7.1510	3.9122

Average Overhead Productivity Indices=129.74, a=129.74, b= 7.30, χ^2 = 41.852, S.D.= 43.03, C.V.= 33.16%.

Analysis and Interpretation

Output: The output of Tata Consultancy Services Ltd. for the year 2010-11 is ₹ 29771.01 crore and reached to ₹ 82424.84 crore in 2017-18.

Power and Fuel: The power and fuel element of overhead input is ₹ 240.00 crore in 2010-11 and reached to ₹ 517.98 crore in 2015-16 while data is not available in case of 2016-17 and 2017-18. Its input output ratio is the highest 0.0081 in 2010-11 while it is the lowest 0.0064 in 2013-14 and 2014-15.

Depreciation and Amortisation: It is ₹ 537.82 crore in 2010-11 and ₹ 1647.00 crore in 2017-18. Also its input output ratio is calculated which is the highest in 2014-15 i.e. 0.0222 and the lowest in 2011-12 i.e. 0.0180.

Repairs and Maintenance: It is ₹ 180.47 crore in 2010-11 and reached to ₹ 529.85 crore in 2015-16 while data is not available in case of 2016-17 and 2017-18. Its input output ratio is the lowest 0.0053 in 2011-12 while it is the highest 0.0071 in 2015-16.

Business Service Input: It is ₹ 9882.48 crore in 2010-11 and reached to ₹ 12820.75 crore in 2017-18. Its input output ratio is the lowest 0.1555 in 2017-18 while it is the highest 0.3319 in 2010-11.

Total Overhead: Total overhead input is the highest ₹ 25760.43 crore in 2015-16 and it is the lowest ₹ 10840.77 crore in 2010-11. Its input output ratio is the lowest 0.1755 in 2017-18 and the highest 0.3641 in 2010-11.

Overhead Productivity Ratio: Overhead productivity ratio is the lowest 2.7462 in 2010-11 while it is the highest 5.6971 in 2017-18. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overhead input has not been utilized efficiently. Improvement in overhead efficiency can also be observed from the average of overhead indices which worked out as 129.74.

Testing Hypothesis and Interpretation: The standard deviation of Tata Consultancy Services Ltd. is 43.03 with 33.16 % of variability. For testing the hypothesis chi-square method has been used. The table value is 14.067 while the calculated value of chi-square is 41.852. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected and the alternative hypothesis is accepted. This reveals that the overhead productivity ratios of the company for the eight year period are not the same and cannot be represented by straight line trend or line of best fit.

Table 6.11

Overhead Productivity of Tech Mahindra Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	5092.10	4875.22	5073.86	13354.17	15545.48	18479.45	19799.98	20288.13
2	Power and Fuel (₹ in Crore)	52.20	48.29	49.14	92.11	97.15	131.11	139.02	128.07
3	Power and Fuel (Input Output Ratio)	0.0103	0.0099	0.0097	0.0069	0.0062	0.0071	0.0070	0.0063
4	Depreciation and Amortisation (₹ in Crore)	138.30	150.50	157.00	427.00	473.30	545.50	622.20	656.20
5	Depreciation and Amortisation (Input Output Ratio)	0.0272	0.0309	0.0309	0.0320	0.0304	0.0295	0.0314	0.0323
6	Repairs and Maintenance (₹ in Crore)	48.90	46.91	43.98	121.58	153.95	185.65	205.34	199.03
7	Repairs and Maintenance (Input Output Ratio)	0.0096	0.0096	0.0087	0.0091	0.0099	0.0100	0.0104	0.0098
8	Business Service Input (₹ in Crore)	1990.10	1884.84	1888.51	4482.21	6758.63	8198.33	9351.75	9002.09
9	Business Service Input (Input Output Ratio)	0.3908	0.3866	0.3722	0.3356	0.4348	0.4436	0.4723	0.4437
10	Total Overhead Input (₹ in Crore)	2229.50	2130.54	2138.63	5122.90	7483.03	9060.59	10318.31	9985.39
11	Total Overhead (Input Output Ratio)	0.4378	0.4370	0.4215	0.3836	0.4814	0.4903	0.5211	0.4922
12	Overhead Productivity Ratio	2.2840	2.2883	2.3725	2.6068	2.0774	2.0395	1.9189	2.0318
13	Overhead Productivity Indices /Observed Indices (O)	100.00	100.19	103.88	114.13	90.96	89.30	84.02	88.96
14	Computed Value /Expected Values (E)	105.81	103.13	100.45	97.77	95.09	92.41	89.73	87.05
15	Chi-Square $(O-E)^2/E$	0.3186	0.0837	0.1170	2.7393	0.1795	0.1048	0.3638	0.0418

Average Overhead Productivity Indices = 96.43, a = 96.43, b = -1.34, χ^2 = 3.948, S.D. = 9.26, C.V. = 9.61 %.

Analysis and Interpretation

Output: The output of Tech Mahindra Ltd. is having an inconsistent trend. It is ₹ 5092.10 crore for the year 2010-11 and reached to ₹ 20288.13 crore in 2017-18.

Power and Fuel: The power and fuel element of overhead input of Tech Mahindra Ltd. is the lowest ₹ 48.29 crore in 2011-12 and the highest ₹ 139.02 crore in 2016-17. Its input output ratio is 0.0103 in 2010-11 and reached to 0.0063 in 2017-18. This means that for any one ₹ of output, 0.0103 as input is required in 2010-11 and so on.

Depreciation and Amortisation: It is the lowest ₹ 138.30 crore in 2010-11 and the highest ₹ 656.20 crore in 2017-18 while its input output ratio is the lowest 0.0272 in 2010-11 and the highest 0.0323 in 2017-18.

Repairs and Maintenance: Repairs and maintenance is the maximum ₹ 205.34 crore in 2016-17 while it is the minimum ₹ 43.98 crore in 2012-13. Its input output ratio is the maximum 0.0104 in 2016-17 while it is the minimum 0.0087 in 2012-13.

Business Service Input: It is ₹ 1990.10 crore in 2010-11 and reached to ₹ 9002.09 crore in 2017-18. Its input output ratio is the lowest 0.3356 in 2013-14 while it is the highest 0.4723 in 2016-17.

Total Overhead: Total overhead input of Tech Mahindra Ltd. is ₹ 2229.50 crore in 2010-11, ₹ 2130.54 crore in 2011-12, ₹ 2138.63 in 2012-13, ₹ 5122.90 crore in 2013-14, ₹ 7483.03 crore in 2014-15, ₹ 9060.59 crore in 2015-16, ₹ 10318.31 in

2016-17 and ₹ 9985.39 crore in 2017-18. Total overhead input output ratio is the lowest in the year 2013-14 with 0.3836 indicating that total overhead has been optimally utilized in this year.

Overhead Productivity Ratio: Overhead productivity ratio of Tech Mahindra Ltd. is more than one in all the years indicating optimum utilisation of overhead input by Tech Mahindra Ltd. The highest overhead productivity ratio is in the year 2013-14 with 2.6068 and the lowest is in the year 2016-17 with 1.9189. Improvement in overhead efficiency can also be observed from the average of overhead indices which worked out to 96.43 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Tech Mahindra Ltd. is 9.26 with coefficient of variation 9.61 %. Chi-square has been used for testing the hypothesis and its table value at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Tech Mahindra Ltd. is 3.948. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This reveals that the overhead productivity ratios of the company for the eight years period are approximately the same and can be represented by straight line trend or line of best fit.

Table 6.12

Overhead Productivity of Wipro Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	26949.60	30252.87	29664.36	32941.35	35024.33	39676.31	40209.89	37750.59
2	Power and Fuel (₹ in Crore)	200.50	204.93	188.70	188.80	197.72	252.69	0.00	0.00
3	Power and Fuel (Input Output Ratio)	0.0074	0.0068	0.0064	0.0057	0.0056	0.0064	-	-
4	Depreciation and Amortisation (₹ in Crore)	600.10	746.10	701.30	736.70	778.40	868.80	1047.70	1014.80
5	Depreciation and Amortisation (Input Output Ratio)	0.0223	0.0247	0.0236	0.0224	0.0222	0.0219	0.0261	0.0269
6	Repairs and Maintenance (₹ in Crore)	152.40	418.98	304.52	325.67	28.61	16.99	0.00	0.00
7	Repairs and Maintenance (Input Output Ratio)	0.0057	0.0138	0.0103	0.0099	0.0008	0.0004	-	-
8	Business Service Input (₹ in Crore)	5475.30	6342.28	6116.68	6622.66	7627.50	9480.53	10111.05	9965.69
9	Business Service Input (Input Output Ratio)	0.2032	0.2096	0.2062	0.2010	0.2178	0.2389	0.2515	0.2640
10	Total Overhead Input (₹ in Crore)	6428.30	7712.28	7311.19	7873.82	8632.23	10619.01	11158.75	10980.49
11	Total Overhead (Input Output Ratio)	0.2385	0.2549	0.2465	0.2390	0.2465	0.2676	0.2775	0.2909
12	Overhead Productivity Ratio	4.1923	3.9227	4.0574	4.1837	4.0574	3.7363	3.6034	3.4380
13	Overhead Productivity Indices /Observed Indices (O)	100.00	93.57	96.78	99.79	96.78	89.12	85.95	82.01
14	Computed Value /Expected Values (E)	100.92	98.66	96.39	94.13	91.87	89.61	87.35	85.08
15	Chi-Square $(O-E)^2/E$	0.0084	0.2624	0.0016	0.3405	0.2626	0.0026	0.0222	0.1113

Average Overhead Productivity Indices = 93.00, a = 93.00, b = -1.13, χ^2 = 1.011, S.D. = 6.22, C.V. = 6.69 %.

Analysis and Interpretation

Output: The output of Wipro Ltd. lies between ₹ 26949.60 crore and ₹ 40209.89 crore. It is the lowest in the year 2010-11 while the highest in the year 2016-17.

Power and Fuel: The power and fuel element of overhead input of Wipro Ltd. is the maximum ₹ 252.69 crore in 2015-16 and it is the minimum ₹ 188.70 crore in 2012-13 while data is not available in case of 2016-17 and 2017-18. The input output ratio is the lowest 0.0056 in 2014-15 while it is the highest 0.0074 in the year 2010-11.

Depreciation and Amortisation: Depreciation and amortisation element lies between ₹ 600.10 crore and ₹ 1047.70 crore. Also its input output ratio lies between 0.0219 and 0.0269.

Repairs and Maintenance: It is ₹ 152.40 crore in 2010-11 as compared to ₹ 16.99 crore in 2015-16 while data is not available in case of 2016-17 and 2017-18. Its input output ratio is the highest 0.0138 in 2011-12 while it is the lowest 0.0004 in 2015-16.

Business Service Input: Business service input is ₹ 5475.30 crore in 2010-11 as compared to ₹ 9965.69 crore in 2017-18. Its input output ratio is the highest 0.2640 in 2017-18 while it is the lowest 0.2010 in 2013-14.

Total Overhead: Total overhead input of Wipro Ltd. varies from ₹ 6428.30 crore to ₹ 11158.75 crore. Total overhead input output ratio is the lowest 0.2385 in 2010-11 indicates that overhead has been optimally utilized in the year 2010-11 as compared to the highest 0.2909 in 2017-18.

Overhead Productivity Ratio: Overhead productivity ratio is the highest 4.1923 in 2010-11 while it is the lowest 3.4380 in 2017-18. The highest overhead productivity ratio is better as more amount of output is obtained with small amount of input. Overhead efficiency can also be observed from the average of overhead indices which worked out to 93.00 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Wipro Ltd. is 6.22 with 6.69 % of variability. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Wipro Ltd. is 1.011. As the calculated value of chi-square is less

as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This reveals that the overhead productivity indices of the Wipro Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

6.3.4. Overhead Productivity of Metals Sector Companies

Overhead productivity of metals sector companies has been elaborated from table 6.13 to 6.16.

Table 6.13

Overhead Productivity of Coal India Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	5473.42	8752.79	9829.37	13365.32	11696.91	14394.79	12656.19	7972.12
2	Power and Fuel (₹ in Crore)	6.20	4.79	5.59	5.26	6.54	11.04	11.70	11.40
3	Power and Fuel (Input Output Ratio)	0.0011	0.0005	0.0006	0.0004	0.0006	0.0008	0.0009	0.0014
4	Depreciation and Amortisation (₹ in Crore)	6.08	6.96	4.96	6.41	7.17	15.13	17.52	18.14
5	Depreciation and Amortisation (Input Output Ratio)	0.0011	0.0008	0.0005	0.0005	0.0006	0.0011	0.0014	0.0023
6	Repairs and Maintenance (₹ in Crore)	7.06	8.70	8.64	6.02	6.23	8.02	11.32	18.88
7	Repairs and Maintenance (Input Output Ratio)	0.0013	0.0010	0.0009	0.0005	0.0005	0.0006	0.0009	0.0024
8	Business Service Input (₹ in Crore)	282.80	166.78	295.34	295.47	198.18	283.16	303.74	200.25
9	Business Service Input (Input Output Ratio)	0.0517	0.0191	0.0300	0.0221	0.0169	0.0197	0.0240	0.0251
10	Total Overhead Input (₹ in Crore)	302.14	187.23	314.54	313.16	218.12	317.35	344.28	248.66
11	Total Overhead (Input Output Ratio)	0.0552	0.0214	0.0320	0.0234	0.0186	0.0220	0.0272	0.0312
12	Overhead Productivity Ratio	18.1155	46.7489	31.2503	42.6788	53.6250	45.3596	36.7608	32.0602
13	Overhead Productivity Indices /Observed Indices (O)	100.00	258.06	172.51	235.59	296.02	250.39	202.92	176.98
14	Computed Value /Expected Values (E)	188.34	194.97	201.61	208.24	214.88	221.51	228.14	234.78
15	Chi-Square $(O-E)^2/E$	41.4356	20.4122	4.2009	3.5924	30.6409	3.7659	2.7875	14.2301

Average Overhead Productivity Indices=211.56, a=211.56, b=3.32, χ^2 =121.065, S.D. =57.69, C.V. = 27.27%.

Analysis and Interpretation

Output: The output of Coal India Ltd. depicts a changing trend. It is the lowest ₹ 5473.42 crore in 2010-11 and it is the highest ₹ 14394.79 crore in 2015-16.

Power and Fuel: It is ₹ 6.20 crore in 2010-11 and reached to ₹ 11.40 crore in 2017-18. Its input output ratio is the highest 0.0014 in 2017-18 while it is the lowest 0.0004 in 2013-14.

Depreciation and Amortisation: It is the highest ₹ 18.14 crore in 2017-18 while it is the lowest ₹ 4.96 crore in 2012-13. Its input output ratio is the lowest 0.0005 in 2012-13 and 2013-14 as compared to the highest 0.0023 in 2017-18.

Repairs and Maintenance: Its range starts from ₹ 6.02 crore to ₹ 18.88 crore. Input output ratio of repairs and maintenance is the lowest 0.0005 in 2013-14 and 2014-15 indicates optimum utilisation.

Business Service Input: It is the highest ₹ 303.74 crore in 2016-17 while it is the lowest ₹ 166.78 crore in 2011-12. Its input output ratio is the lowest 0.0169 in 2014-15 as compared to the highest 0.0517 in 2010-11.

Total Overhead: Total overhead input is ₹ 302.14 crore in 2010-11 and after facing many fluctuation during the period of eight years reached to ₹ 248.66 crore in 2017-18. Its input output ratio is the highest 0.0552 in 2010-11 while it is the lowest 0.0186 in 2014-15. The lowest overhead input output ratio means overhead input has been best utilized in the year 2014-15.

Overhead Productivity Ratio: There is a fluctuating trend in the overhead productivity ratio of Coal India Ltd. It is the lowest 18.1155 in 2010-11 while it is the highest 53.6250 in 2014-15. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overhead input has not been utilized efficiently. Improvement in overhead efficiency can also be observed from the average of overhead indices which worked out to 211.56 which is much higher than the base year index of 100.

Testing Hypothesis and Interpretation: In Coal India Ltd. the standard deviation calculated is 57.69 and coefficient of variation is 27.27 % indicates variability. The computed value of chi-square is 121.065 while the table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This reveals that the overhead productivity indices of the company for the study period are not same and cannot be represented by straight line trend or line of best fit.

Table 6.14

Overhead Productivity of Hindalco Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	23812.03	24607.23	23337.28	23092.10	28592.89	29776.75	30320.65	34617.98
2	Power and Fuel (₹ in Crore)	2221.48	2520.45	2516.82	2721.57	4238.63	6599.17	5998.95	5646.11
3	Power and Fuel (Input Output Ratio)	0.0933	0.1024	0.1078	0.1179	0.1482	0.2216	0.1979	0.1631
4	Depreciation and Amortisation (₹ in Crore)	687.48	689.97	704.20	823.29	837.03	1277.00	1427.97	1617.31
5	Depreciation and Amortisation (Input Output Ratio)	0.0289	0.0280	0.0302	0.0357	0.0293	0.0429	0.0471	0.0467
6	Repairs and Maintenance (₹ in Crore)	286.10	235.87	253.89	361.11	425.02	443.69	447.06	495.67
7	Repairs and Maintenance (Input Output Ratio)	0.0120	0.0096	0.0109	0.0156	0.0149	0.0149	0.0147	0.0143
8	Business Service Input (₹ in Crore)	1115.49	1011.01	1229.98	1134.53	1636.36	1821.09	2562.16	2619.31
9	Business Service Input (Input Output Ratio)	0.0468	0.0411	0.0527	0.0491	0.0572	0.0612	0.0845	0.0757
10	Total Overhead Input (₹ in Crore)	4310.55	4457.30	4704.89	5040.50	7137.03	10140.95	10436.14	10378.40
11	Total Overhead (Input Output Ratio)	0.1810	0.1811	0.2016	0.2183	0.2496	0.3406	0.3442	0.2998
12	Overhead Productivity Ratio	5.5241	5.5207	4.9602	4.5813	4.0063	2.9363	2.9054	3.3356
13	Overhead Productivity Indices /Observed Indices (O)	100.00	99.94	89.79	82.93	72.52	53.15	52.59	60.38
14	Computed Value /Expected Values (E)	102.85	95.29	87.74	80.19	72.64	65.09	57.53	49.98
15	Chi-Square $(O-E)^2/E$	0.0788	0.2262	0.0479	0.0938	0.0002	2.1876	0.4242	2.1638

Average Overhead Productivity Indices=76.41, a = 76.41, b = -3.78, χ^2 = 5.222, S.D. = 18.41, C.V. = 24.09%.

Analysis and Interpretation

Output: The revalued output of Hindalco Ltd. is ₹ 23812.03 crore in 2010-11 and reached to ₹ 34617.98 crore in 2017-18.

Power and Fuel: It is the highest ₹ 6599.17 crore in 2015-16 and the lowest ₹ 2221.48 crore in 2010-11. Its input output ratio is the highest 0.2216 in 2015-16 while it is the lowest 0.0933 in 2010-11.

Depreciation and Amortisation: It is the highest ₹ 1617.31 crore in 2017-18 while it is the lowest ₹ 687.48 crore in 2010-11. Input output ratio of depreciation and amortisation is the lowest 0.0280 in 2011-12 while it is the highest 0.0471 in 2016-17.

Repairs and Maintenance: It is the lowest ₹ 235.87 crore in 2011-12 as compared to the highest ₹ 495.67 crore in 2017-18. Input output ratio of repairs and maintenance is the lowest 0.0096 in 2011-12 indicating that less has been expended on repairs and maintenance element of overhead input.

Business Service Input: It is the highest ₹ 2619.31 crore in 2017-18 and the lowest ₹ 1011.01 crore in 2011-12. Its input output ratio is the highest 0.0845 in 2016-17 while it is the lowest 0.0411 in 2011-12.

Total Overhead: Total overhead input consumption of Hindalco Ltd. is ₹ 4310.55 crore in 2010-11, then it is increased and reached to ₹ 10436.14 crore in 2016-17, then it decreased and reached to ₹ 10378.40 crore in 2017-18. Total overhead input output ratio is the lowest 0.1810 in 2010-11 while it is the highest 0.3442 in 2016-17.

Overhead Productivity Ratio: Overhead productivity ratio is the lowest 2.9054 in 2016-17 while it is the highest 5.5241 in 2010-11. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overhead input has not been utilized efficiently. Overhead efficiency can also be observed from the average of overhead indices which worked out to 76.41 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: Standard deviation of Hindalco Ltd. is 18.41 while its coefficient of variation is 24.09 %. The computed value of chi-square is 5.222. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as

compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the overhead productivity indices of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 6.15

Overhead Productivity of Tata Steel Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	29751.06	31762.04	33240.61	34552.29	33571.38	35358.24	43080.57	49400.88
2	Power and Fuel (₹ in Crore)	1146.19	1010.96	1343.47	1475.46	1628.04	1960.17	3601.76	3507.54
3	Power and Fuel (Input Output Ratio)	0.0385	0.0318	0.0404	0.0427	0.0485	0.0554	0.0836	0.0710
4	Depreciation and Amortisation (₹ in Crore)	1558.49	1990.16	2510.17	2772.31	2704.42	2881.17	2880.92	2925.20
5	Depreciation and Amortisation (Input Output Ratio)	0.0524	0.0627	0.0755	0.0802	0.0806	0.0815	0.0669	0.0592
6	Repairs and Maintenance (₹ in Crore)	1104.10	1123.66	1259.72	1475.64	1564.41	1743.23	1936.21	2136.85
7	Repairs and Maintenance (Input Output Ratio)	0.0371	0.0354	0.0379	0.0427	0.0466	0.0493	0.0449	0.0433
8	Business Service Input (₹ in Crore)	4746.19	5910.63	6422.93	6653.64	6909.40	7072.80	13782.14	10335.31
9	Business Service Input (Input Output Ratio)	0.1595	0.1861	0.1932	0.1926	0.2058	0.2000	0.3199	0.2092
10	Total Overhead Input (₹ in Crore)	8554.97	10035.41	11536.30	12377.04	12806.26	13657.37	22201.02	18904.90
11	Total Overhead (Input Output Ratio)	0.2876	0.3160	0.3471	0.3582	0.3815	0.3863	0.5153	0.3827
12	Overhead Productivity Ratio	3.4776	3.1650	2.8814	2.7916	2.6215	2.5889	1.9405	2.6131
13	Overhead Productivity Indices /Observed Indices (O)	100.00	91.01	82.85	80.27	75.38	74.45	55.80	75.14
14	Computed Value /Expected Values (E)	95.20	90.68	86.15	81.63	77.10	72.57	68.05	63.52
15	Chi-Square $(O-E)^2/E$	0.2416	0.0012	0.1262	0.0224	0.0383	0.0483	2.2050	2.1253

Average Overhead Productivity Indices= 79.36, a= 79.36, b = -2.26, χ^2 = 4.808, S.D. = 12.18, C.V. = 15.35%.

Analysis and Interpretation

Output: The output of Tata Steel Ltd. is ₹ 29751.06 crore in 2010-11, then increased and reached to ₹ 34552.29 crore in 2013-14 then it deceased in the year 2014-15 then again it increased and reached to ₹ 49400.88 crore in 2017-18.

Power and Fuel: It is ₹ 1146.19 crore in 2010-11 and reached to ₹ 3507.54 crore in 2017-18. Its input output ratio is the highest 0.0836 in 2016-17 while it is the lowest 0.0318 in 2011-12. The lowest power and fuel input output ratio indicates optimum utilisation of power and fuel element of overhead input in this year.

Depreciation and Amortisation: Depreciation and amortisation consumption is the highest ₹ 2925.20 crore in 2017-18 while it is the lowest ₹ 1558.49 crore in 2010-11. Its input output ratio is the lowest 0.0524 in 2010-11 as compared to the highest 0.0815 in 2015-16.

Repairs and Maintenance: It is showing an increasing trend with the highest ₹ 2136.85 crore in 2017-18 while it is the lowest ₹ 1104.10 crore in 2010-11. Its input output ratio is the lowest 0.0354 in 2011-12 while it is the highest 0.0493 in 2015-16.

Business Service Input: It is ₹ 4746.19 crore in 2010-11, then it increased and reached to ₹ 13782.14 crore in 2016-17 then it deceased in the year 2017-18 and reached to ₹ 10335.31 crore. Its input output ratio is the lowest 0.1595 in 2010-11 while it is the highest 0.3199 in 2016-17.

Total Overhead: Total overhead input of Tata Steel Ltd. range between ₹ 8554.97 crore to ₹ 22201.02 crore. It is the lowest in 2010-11 while the highest in 2016-17. Total overhead input output ratio is the highest 0.5153 in 2016-17 while it is the lowest 0.2876 in 2010-11. The lowest overhead input output ratio means overhead has been optimally utilized in the year 2010-11.

Overhead Productivity Ratio: Overhead productivity ratio of Tata Steel Ltd. is the lowest 1.9405 in 2016-17 and the highest 3.4776 in 2010-11. Improvement in overhead efficiency can also be observed from the average of overhead indices which is 79.36 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Tata Steel Ltd. is 12.18 with 15.35 % of variability. The computed value of chi-square is 4.808 as compared to the table value 14.067 at 5% level of significance with (8-1) = 7 degree of freedom. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted. This reveals that the overhead productivity indices of the Tata Steel Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 6.16

Overhead Productivity of Vedanta Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	7996.15	6378.58	2133.63	24314.13	28028.71	32447.13	37817.67	39453.82
2	Power and Fuel (₹ in Crore)	14.97	13.32	456.58	3575.36	3612.94	4422.48	4659.89	6251.06
3	Power and Fuel (Input Output Ratio)	0.0019	0.0021	0.2140	0.1470	0.1289	0.1363	0.1232	0.1584
4	Depreciation and Amortisation (₹ in Crore)	83.13	83.85	147.91	1504.79	1011.67	1217.97	2986.00	2842.00
5	Depreciation and Amortisation (Input Output Ratio)	0.0104	0.0131	0.0693	0.0619	0.0361	0.0375	0.0790	0.0720
6	Repairs and Maintenance (₹ in Crore)	23.15	19.51	27.55	216.03	298.13	274.75	405.74	448.24
7	Repairs and Maintenance (Input Output Ratio)	0.0029	0.0031	0.0129	0.0089	0.0106	0.0085	0.0107	0.0114
8	Business Service Input (₹ in Crore)	2099.81	2215.39	813.52	1757.61	1372.70	1447.01	2868.16	2937.92
9	Business Service Input (Input Output Ratio)	0.2626	0.3473	0.3813	0.0723	0.0490	0.0446	0.0758	0.0745
10	Total Overhead Input (₹ in Crore)	2221.06	2332.07	1445.55	7053.78	6295.44	7362.21	10919.79	12479.23
11	Total Overhead (Input Output Ratio)	0.2778	0.3656	0.6775	0.2901	0.2246	0.2269	0.2887	0.3163
12	Overhead Productivity Ratio	3.6002	2.7352	1.4760	3.4470	4.4522	4.4073	3.4632	3.1616
13	Overhead Productivity Indices /Observed Indices (O)	100.00	75.97	41.00	95.74	123.67	122.42	96.20	87.82
14	Computed Value /Expected Values (E)	80.85	84.28	87.71	91.14	94.57	98.00	101.42	104.85
15	Chi-Square $(O-E)^2/E$	4.5352	0.8187	24.8765	0.2329	8.9554	6.0870	0.2694	2.7678

Average Overhead Productivity Indices= 92.85, a= 92.85, b= 1.71, χ^2 = 48.543, S.D. = 24.73, C.V. = 26.64%.

Analysis and Interpretation

Output: The output of Vedanta Ltd. is the highest ₹ 39453.82 crore in 2017-18 while it is the lowest ₹ 2133.63 crore in 2012-13.

Power and Fuel: It is the highest ₹ 6251.06 crore in 2017-18 and the lowest ₹ 14.97 crore in 2010-11. Its input output ratio is the highest 0.2140 in 2012-13 while it is the lowest 0.0019 in 2010-11.

Depreciation and Amortisation: Its consumption is the highest ₹ 2986.00 crore in 2016-17 while it is the lowest ₹ 83.13 crore in 2010-11. Its input output ratio is the highest 0.0790 in 2016-17 as compared to the lowest 0.0104 in 2010-11.

Repairs and Maintenance: It is the lowest ₹ 19.51 crore in 2011-12 as compared to the highest ₹ 448.24 crore in 2017-18. Its input output ratio is the lowest 0.0029 in 2010-11 indicates less has been expended on repairs and maintenance. It is the highest 0.0129 in 2012-13.

Business Service Input: It is the minimum ₹ 813.52 crore in 2012-13 as compared to the maximum ₹ 2937.92 crore in 2017-18. Its input output ratio is the minimum 0.0446 in 2015-16 while it is the maximum 0.3813 in 2012-13.

Total Overhead: Total overhead input consumption of Vedanta Ltd. is ₹ 2221.06 crore in 2010-11 then after facing a lot of fluctuation during the period of eight years it ultimately reached to ₹ 12479.23 crore in 2017-18. Total overhead input output ratio is the highest 0.6775 in 2012-13 while it is the lowest 0.2246 in 2014-15.

Overhead Productivity Ratio: Overhead productivity ratio of Vedanta Ltd. is 3.6002 in 2010-11 and reached to 3.1616 in 2017-18. Overhead productivity ratio is the lowest 1.4760 in 2012-13 while it is the highest 4.4522 in 2014-15. Overhead efficiency can also be analysed from the average of overhead indices. It is 92.85 which is less than the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Vedanta Ltd. is 24.73 with coefficient of variation 26.64 %. The computed value of chi-square is 48.543. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This reveals that the overhead productivity indices of the

Vedanta Ltd. for the study period are not same and cannot be represented by straight line trend or line of best fit.

6.3.5. Overhead Productivity of Pharmaceutical Sector Companies

Overhead productivity of pharmaceutical sector companies has been conveyed from table 6.17 to 6.20

Table 6.17

Overhead Productivity of Cipla Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	6308.14	6551.80	6992.95	7754.00	8004.10	10480.54	9185.26	9242.54
2	Power and Fuel (₹ in Crore)	164.42	185.54	172.95	146.76	161.52	210.47	209.79	224.91
3	Power and Fuel (Input Output Ratio)	0.0261	0.0283	0.0247	0.0189	0.0202	0.0201	0.0228	0.0243
4	Depreciation and Amortisation (₹ in Crore)	228.86	282.07	303.03	323.61	433.20	440.81	751.38	529.61
5	Depreciation and Amortisation (Input Output Ratio)	0.0363	0.0431	0.0433	0.0417	0.0541	0.0421	0.0818	0.0573
6	Repairs and Maintenance (₹ in Crore)	127.64	160.64	84.49	66.33	64.09	73.76	81.11	80.52
7	Repairs and Maintenance (Input Output Ratio)	0.0202	0.0245	0.0121	0.0086	0.0080	0.0070	0.0088	0.0087
8	Business Service Input (₹ in Crore)	1332.07	1213.51	1421.71	1622.38	1871.43	2413.47	2351.85	2275.88
9	Business Service Input (Input Output Ratio)	0.2112	0.1852	0.2033	0.2092	0.2338	0.2303	0.2560	0.2462
10	Total Overhead Input (₹ in Crore)	1852.99	1841.76	1982.17	2159.08	2530.24	3138.51	3394.14	3110.92
11	Overhead (Input Output Ratio)	0.2937	0.2811	0.2835	0.2784	0.3161	0.2995	0.3695	0.3366
12	Overhead Productivity Ratio	3.4043	3.5574	3.5279	3.5913	3.1634	3.3393	2.7062	2.9710
13	Overhead Productivity Indices /Observed Indices (O)	100.00	104.50	103.63	105.49	92.92	98.09	79.49	87.27
14	Computed Value /Expected Values (E)	106.56	103.67	100.77	97.87	94.98	92.08	89.18	86.29
15	Chi-Square $(O-E)^2/E$	0.4041	0.0066	0.0812	0.5934	0.0444	0.3924	1.0529	0.0112

Average Overhead Productivity Indices = 96.43, a = 96.43, b = - 1.45, χ^2 = 2.586, S.D. = 8.64, C.V. = 8.96%.

Analysis and Interpretation

Output: The revalued output of Cipla Ltd. highlighted an increasing trend except in the year 2016-17. It is the highest ₹ 10480.54 crore in 2015-16 and it is the lowest ₹ 6308.14 crore in 2010-11.

Power and Fuel: The most important part of the overhead input is power and fuel. It is showing a fluctuating trend. Its input output ratio lies between 0.0189 and 0.0283. The lowest power and fuel input output ratio is in 2013-14 indicates optimum power and fuel utilisation.

Depreciation and Amortisation: Another part of the total overhead input is depreciation and amortisation. The input output ratio of depreciation and amortisation is the lowest 0.0363 in 2010-11 as compared to the highest 0.0818 in 2016-17.

Repairs and Maintenance: It displays a choppy trend. It is ₹ 127.64 crore in 2010-11 and ₹ 160.64 crore in 2011-12 then it decreased and reached to ₹ 64.09 crore in 2014-15 then with some fluctuations it ultimately reached to ₹ 80.52 crore

in 2017-18. Its input output ratio is the lowest 0.0070 in 2015-16 indicates optimum utilisation.

Business Service Input: Business service input element of overhead input is conveying a changing trend. Its input output ratio is the lowest 0.1852 in 2011-12 indicates optimum utilisation as compared to 0.2560 in 2016-17.

Total Overhead: Total overhead range from ₹ 1852.99 crore to ₹ 3394.14 crore. Its input output ratio lies between 0.2784 and 0.3695. The lowest overhead input output ratio in the year 2013-14 means overhead has been best utilised in the year 2013-14.

Overhead Productivity Ratio: There is inconsistency in the overhead productivity ratios of Cipla Ltd. It is 3.4043 in 2010-11, 3.5574 in 2011-12, 3.5279 in 2012-13, 3.5913 in 2013-14, 3.1634 in 2014-15, 3.3393 in 2015-16, 2.7062 in 2016-17 and 2.9710 in 2017-18. Overhead productivity ratio is the lowest 2.7062 in 2016-17 while it is the highest 3.5913 in 2013-14. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overhead input has not been utilised efficiently and mismanagement may be responsible for the low productivity. Improvement in overhead efficiency can also be observed from the average of overhead indices which worked out to 96.43 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation is 8.64 with 8.96 % of variability of Cipla Ltd. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Cipla Ltd. is 2.586. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This reveals that the overhead productivity indices of the Cipla Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 6.18

Overhead Productivity of Dr. Reddy's Laboratories Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	5345.10	6165.93	7280.11	7922.46	8225.15	8724.64	8487.52	7599.85
2	Power and Fuel (₹ in Crore)	144.60	155.85	231.45	197.45	242.14	281.99	301.34	279.76
3	Power and Fuel (Input Output Ratio)	0.0271	0.0253	0.0318	0.0249	0.0294	0.0323	0.0355	0.0368
4	Depreciation and Amortisation (₹ in Crore)	247.90	301.10	312.80	380.50	490.20	649.10	735.10	774.10
5	Depreciation and Amortisation (Input Output Ratio)	0.0464	0.0488	0.0430	0.0480	0.0596	0.0744	0.0866	0.1019
6	Repairs and Maintenance (₹ in Crore)	160.40	164.14	118.63	143.53	163.05	198.12	232.42	225.64
7	Repairs and Maintenance (Input Output Ratio)	0.0300	0.0266	0.0163	0.0181	0.0198	0.0227	0.0274	0.0297
8	Business Service Input (₹ in Crore)	1442.30	1796.62	1905.43	2254.28	2021.85	2457.10	2106.72	1971.69
9	Business Service Input (Input Output Ratio)	0.2698	0.2914	0.2617	0.2845	0.2458	0.2816	0.2482	0.2594
10	Total Overhead Input (₹ in Crore)	1995.20	2417.70	2568.31	2975.76	2917.24	3586.31	3375.57	3251.19
11	Total Overhead (Input Output Ratio)	0.3733	0.3921	0.3528	0.3756	0.3547	0.4111	0.3977	0.4278
12	Overhead Productivity Ratio	2.6790	2.5503	2.8346	2.6623	2.8195	2.4328	2.5144	2.3376
13	Overhead Productivity Indices /Observed Indices (O)	100.00	95.20	105.81	99.38	105.25	90.81	93.86	87.26
14	Computed Value /Expected Values (E)	102.82	101.21	99.61	98.00	96.39	94.78	93.17	91.57
15	Chi-Square $(O-E)^2/E$	0.0774	0.3575	0.3863	0.0195	0.8135	0.1665	0.0050	0.2030

Average Overhead Productivity Indices = 97.19, a = 97.19, b = - 0.80, χ^2 = 2.029, S.D. = 6.19, C.V. = 6.37 %.

Analysis and Interpretation

Output: The revalued output of Dr. Reddy's Laboratories Ltd. for the year 2010-11 is ₹ 5345.10 crore, for year 2011-12 output becomes ₹ 6165.93 crore, for 2012-13 it is ₹ 7280.11 crore, for 2013-14 ₹ 7922.46 crore, for 2014-15 ₹ 8225.15 crore, for 2015-16 output is ₹ 8724.64 crore, for 2016-17 output is 8487.52 crore and for 2017-18 it is 7599.85 crore.

Power and Fuel: The power and fuel element in Dr. Reddy's Laboratories Ltd. is ₹ 144.60 crore, ₹ 155.85 crore, ₹ 231.45 crore, ₹ 197.45 crore, ₹ 242.14 crore, ₹ 281.99 crore, ₹ 301.34 crore and ₹ 279.76 crore respectively from 2010-11 to 2017-18 respectively. Its input output ratio is the highest 0.0368 in 2017-18 while it is the lowest 0.0249 in 2013-14 indicates that power and fuel is optimally utilised in year 2013-14.

Depreciation and Amortisation: Another part to analyse in the total overhead input is depreciation and amortisation. It is showing an increasing trend. It is ₹ 247.90 crore in 2010-11 and reached to ₹ 774.10 crore in 2017-18. Also depreciation and amortisation input output ratio is calculated which is the highest in 2017-18 i.e. 0.1019 and the lowest in 2012-13 i.e. 0.0430.

Repairs and Maintenance: It is manifesting an erratic trend. Its input output ratio is 0.0300 in 2010-11, 0.0266 in 2011-12, 0.0163 in 2012-13, 0.0181 in 2013-14, 0.0198 in 2014-15, 0.0227 in 2015-16, 0.0274 in 2016-17 and 0.0297 in 2017-18.

Business Service Input: It is showing an increasing trend till the year 2013-14 and after this it decreased in the year 2014-15 and then increased and ultimately decreased and reached to 1971.69 crore. Its input output ratio lies between 0.2458 and 0.2914.

Total Overhead: Total overhead input is the minimum 1995.20 in the year 2010-11 as compared to the maximum 3586.31 in 2015-16. Its input output ratio is the maximum 0.4278 in 2017-18 as compared to the minimum 0.3528 in 2012-13 respectively.

Overhead Productivity Ratio: Overhead productivity ratio is changeful in nature. It is the lowest 2.3376 in 2017-18 while it is the highest 2.8346 in 2012-13. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overhead input has not been utilized efficiently. Improvement in overhead efficiency can also be observed from the average of overhead indices which is 97.19 as compared to the base year.

Testing Hypothesis and Interpretation: The standard deviation of Dr. Reddy's Laboratories Ltd. is 6.19 with 6.37 % of variability. For testing the hypothesis chi-square test has been used. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Dr. Reddy's Laboratories Ltd. is 2.029. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This reveals that the overhead productivity ratios of the Dr. Reddy's Laboratories Ltd. for the eight year period are approximately the same and can be represented by straight line trend or line of best fit.

Table 6.19

Overhead Productivity of Lupin Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	4510.95	4824.82	5981.54	7571.30	7868.41	9452.23	10416.18	8232.87
2	Power and Fuel (₹ in Crore)	196.83	225.76	245.50	236.66	274.16	355.25	339.91	358.82
3	Power and Fuel (Input Output Ratio)	0.0436	0.0468	0.0410	0.0313	0.0348	0.0376	0.0326	0.0436
4	Depreciation and Amortisation (₹ in Crore)	104.28	131.96	150.14	167.63	336.79	305.61	366.11	389.81
5	Depreciation and Amortisation (Input Output Ratio)	0.0231	0.0274	0.0251	0.0221	0.0428	0.0323	0.0351	0.0473
6	Repairs and Maintenance (₹ in Crore)	65.91	74.28	95.39	106.06	127.40	146.43	183.04	191.35
7	Repairs and Maintenance (Input Output Ratio)	0.0146	0.0154	0.0159	0.0140	0.0162	0.0155	0.0176	0.0232
8	Business Service Input (₹ in Crore)	861.22	971.97	1179.13	1302.46	1201.85	1536.21	2053.95	1655.74
9	Business Service Input (Input Output Ratio)	0.1909	0.2015	0.1971	0.1720	0.1527	0.1625	0.1972	0.2011
10	Total Overhead Input (₹ in Crore)	1228.24	1403.97	1670.17	1812.80	1940.20	2343.51	2943.02	2595.72
11	Total Overhead (Input Output Ratio)	0.2723	0.2910	0.2792	0.2394	0.2466	0.2479	0.2825	0.3153
12	Overhead Productivity Ratio	3.6727	3.4365	3.5814	4.1766	4.0555	4.0334	3.5393	3.1717
13	Overhead Productivity Indices /Observed Indices (O)	100.00	93.57	97.51	113.72	110.42	109.82	96.37	86.36
14	Computed Value /Expected Values (E)	102.97	102.40	101.83	101.26	100.69	100.12	99.55	98.98
15	Chi-Square $(O-E)^2/E$	0.0855	0.7608	0.1826	1.5339	0.9413	0.9405	0.1015	1.6085

Average Overhead Productivity Indices= 100.97, a= 100.97, b = -0.28, χ^2 = 6.155, S.D. = 8.89, C.V. = 8.81%.

Analysis and Interpretation

Output: The output of Lupin Ltd. is highlighting an increasing trend except in year 2017-18. It is ₹ 4510.95 crore for the year 2010-11 and it reached to ₹ 8232.87 crore in 2017-18.

Power and Fuel: The power and fuel element of the overhead input of Lupin Ltd. lies between ₹ 196.83 crore in 2010-11 and ₹ 358.82 crore in 2017-18. Its input output ratio is showing an erratic trend. It is 0.0436 in 2010-11, 0.0468 in 2011-12, 0.0410 in 2012-13, 0.0313 in 2013-14, 0.0348 in 2014-15, 0.0376 in 2015-16, 0.0326 in 2016-17 and 0.0436 in 2017-18. This means that for any one ₹ of output 0.0436 as input is required in 2010-11 and so on.

Depreciation and Amortisation: Another section in total overhead input is depreciation and amortisation. It is ₹ 104.28 crore in 2010-11 then it increased and reached to ₹ 336.79 crore in 2014-15 then it decreased to ₹ 305.61 crore in 2015-16 and ultimately increased and reached to ₹ 389.81 crore in 2017-18. Also its input output ratio is 0.0231, 0.0274, 0.0251, 0.0221, 0.0428, 0.0323, 0.0351 and 0.0473 respectively from 2010-11 to 2017-18.

Repairs and Maintenance: It is depicting an upward trend with ₹ 65.91 crore in 2010-11 and ₹ 191.35 crore in 2017-18. Its input output ratio is the lowest 0.0140 in 2013-14 and the highest 0.0232 in 2017-18.

Business Service Input: Business service input element of overhead input of Lupin Ltd. is the highest ₹ 2053.95 crore in 2016-17 while it is the lowest ₹ 861.22 crore in 2010-11. Its input output ratio is the lowest 0.1527 in 2014-15 indicates optimum utilisation.

Total Overhead: Total overhead input of Lupin Ltd. is conveying an upward trend except in the year 2017-18. Total overhead input output ratio is the lowest 0.2394 in the year 2013-14 indicating that total overhead has been optimally utilized in this year.

Overhead Productivity Ratio: Overhead productivity ratio is changeable in nature. It is 3.6727 in 2010-11, 3.4365 in 2011-12, 3.5814 in 2012-13, 4.1766 in 2013-14, 4.0555 in 2014-15, 4.0334 in 2015-16, 3.5393 in 2016-17, 3.1717 in 2017-18. The highest overhead productivity ratio in 2013-14 with 4.1766 indicates that overhead input has been best utilized in 2013-14. It represents that for one ₹ of input approx. ₹ 4 of output is obtained in 2013-14 and so on. Improvement in overhead efficiency can also be observed from the average of overhead indices which worked out as 100.97 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Lupin Ltd. is 8.89 with coefficient of variation 8.81 %. Chi-square has been used for testing the hypothesis and its table value at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Lupin Ltd. is 6.155. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This reveals that the overhead productivity ratios of the Lupin Ltd. for the eight year period are approximately the same and can be represented by straight line trend or line of best fit.

Table 6.20

Overhead Productivity of Sun Pharmaceutical Industries Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	3300.23	3925.99	2283.03	2426.49	6888.78	6677.42	6699.57	7378.69
2	Power and Fuel (₹ in Crore)	39.40	60.37	76.49	88.59	311.75	375.67	355.17	353.98
3	Power and Fuel (Input Output Ratio)	0.0119	0.0154	0.0335	0.0365	0.0453	0.0563	0.0530	0.0480
4	Depreciation and Amortisation (₹ in Crore)	64.23	75.72	85.82	101.94	660.68	463.98	422.28	432.23
5	Depreciation and Amortisation (Input Output Ratio)	0.0195	0.0193	0.0376	0.0420	0.0959	0.0695	0.0630	0.0586
6	Repairs and Maintenance (₹ in Crore)	34.01	47.11	62.76	71.15	161.68	167.98	174.54	176.91
7	Repairs and Maintenance (Input Output Ratio)	0.0103	0.0120	0.0275	0.0293	0.0235	0.0252	0.0261	0.0240
8	Business Service Input (₹ in Crore)	562.31	591.41	387.23	880.50	2133.55	2105.90	1556.80	1315.23
9	Business Service Input (Input Output Ratio)	0.1704	0.1506	0.1696	0.3629	0.3097	0.3154	0.2324	0.1782
10	Total Overhead Input (₹ in Crore)	699.95	774.62	612.30	1142.17	3267.67	3113.52	2508.79	2278.34
11	Total Overhead (Input Output Ratio)	0.2121	0.1973	0.2682	0.4707	0.4743	0.4663	0.3745	0.3088
12	Overhead Productivity Ratio	4.7150	5.0683	3.7286	2.1245	2.1082	2.1446	2.6704	3.2386
13	Overhead Productivity Indices /Observed Indices (O)	100.00	107.49	79.08	45.06	44.71	45.49	56.64	68.69
14	Computed Value /Expected Values (E)	92.34	85.50	78.66	71.81	64.97	58.13	51.29	44.45
15	Chi-Square $(O-E)^2/E$	0.6361	5.6605	0.0023	9.9692	6.3187	2.7517	0.5568	13.2126

Average Overhead Productivity Indices=68.39, a=68.39, b= - 3.42, χ^2 = 39.108, S.D. = 23.48, C.V. = 34.33%.

Analysis and Interpretation

Output: The output of Sun Pharmaceutical Industries Ltd. is having a inconsistent trend. Output in 2010-11 is ₹ 3300.23 crore, in 2011-12 ₹ 3925.99 crore, in 2012-13 ₹ 2283.03 crore, in 2013-14 ₹ 2426.49 crore, in 2014-15 ₹ 6888.78 crore, in 2015-16 ₹ 6677.42 crore, in 2016-17 ₹ 6699.57 crore, in 2017-18 ₹ 7378.69 crore.

Power and Fuel: The power and fuel consumption of Sun Pharmaceutical Industries Ltd. is showing an increasing trend till 2015-16 after that it is decreasing. Its input output ratio is the lowest 0.0119 in 2010-11 while it is the highest 0.0563 in the year 2015-16.

Depreciation and Amortisation: It is the lowest ₹ 64.23 crore in 2010-11 while it is the highest ₹ 660.68 crore in 2014-15. Its input output ratio is the lowest 0.0193 in 2011-12 which indicates that for every ₹ of output produced ₹ 0.0193 of input is required.

Repairs and Maintenance: Repairs and maintenance segment of overhead input is showing an increasing trend. It is the lowest ₹ 34.01 crore in 2010-11 while the highest is ₹ 176.91 crore in 2017-18. Its input output ratio is the lowest 0.0103 in 2010-11 and it is the highest 0.0293 in 2013-14.

Business Service Input: It is the minimum ₹ 387.23 crore in 2012-13 while it is the maximum ₹ 2133.55 crore in 2014-15. Its input output ratio is the lowest 0.1506 while it is the highest 0.3629.

Total Overhead: Total overhead of Sun Pharmaceutical Industries Ltd. is presenting a choppy trend. It is ₹ 699.95 crore in 2010-11, ₹ 774.62 crore in 2011-12, ₹ 612.30 crore in 2012-13, ₹ 1142.17 crore in 2013-14, ₹ 3267.67 crore in 2014-15, ₹ 3113.52 crore in 2015-16, ₹ 2508.79 crore in 2016-17 and ₹ 2278.34 crore in 2017-18. Total overhead input output ratio is the highest 0.4743 in 2014-15 while it is the lowest 0.1973 in 2011-12. The lowest ratio portrays that overhead input has been optimally utilized in the year 2011-12.

Overhead Productivity Ratio: It is the highest 5.0683 in 2011-12 which means that for one ₹ of input approx. ₹ 5 of output is obtained. It is the lowest 2.1082 in 2014-15 which means that for one ₹ of input approx. ₹ 2 of output is obtained. So the highest overhead productivity ratio is better as it gives more output with small amount of input. Overhead efficiency can also be observed from the average of overhead indices which worked out to 68.39 as compared to the base year index of 100. This indicates that overhead is not being able to utilize efficiently as compared to the base year.

Testing Hypothesis and Interpretation: The standard deviation of Sun Pharmaceutical Industries Ltd. is 23.48 with 34.33 % of variability. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Sun Pharmaceutical Industries Ltd. is 39.108. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected and the alternative hypothesis is accepted. This reveals that the overhead productivity indices of the Sun Pharmaceutical Industries Ltd. for the study period are not approximately same and cannot be represented by straight line trend or line of best fit.

6.3.6. Overhead Productivity of Refineries Sector Companies

Overhead productivity of refineries sector companies has been elaborated from table 6.21 to 6.24.

Table 6.21

Overhead Productivity of Bharat Petroleum Corporation Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	151243.98	195601.15	206438.48	211751.09	197308.95	160737.40	163969.29	191476.02
2	Power and Fuel (₹ in Crore)	475.89	628.72	741.13	915.62	1414.94	1584.19	1331.62	1646.28
3	Power and Fuel (Input Output Ratio)	0.0031	0.0032	0.0036	0.0043	0.0072	0.0099	0.0081	0.0086
4	Depreciation and Amortisation (₹ in Crore)	1655.40	1884.87	1926.10	2246.82	2516.02	1854.30	1891.32	2648.48
5	Depreciation and Amortisation (Input Output Ratio)	0.0109	0.0096	0.0093	0.0106	0.0128	0.0115	0.0115	0.0138
6	Repairs and Maintenance (₹ in Crore)	537.51	584.61	678.83	823.21	709.67	763.00	785.73	875.35
7	Repairs and Maintenance (Input Output Ratio)	0.0036	0.0030	0.0033	0.0039	0.0036	0.0047	0.0048	0.0046
8	Business Service Input (₹ in Crore)	5342.97	6570.06	6427.37	6998.46	7101.38	8499.79	7528.43	8740.20
9	Business Service Input (Input Output Ratio)	0.0353	0.0336	0.0311	0.0331	0.0360	0.0529	0.0459	0.0456
10	Total Overhead Input (₹ in Crore)	8011.77	9668.26	9773.44	10984.12	11742.01	12701.29	11537.10	13910.31
11	Total Overhead (Input Output Ratio)	0.0530	0.0494	0.0473	0.0519	0.0595	0.0790	0.0704	0.0726
12	Overhead Productivity Ratio	18.8777	20.2313	21.1224	19.2779	16.8037	12.6552	14.2123	13.7650
13	Overhead Productivity Indices /Observed Indices (O)	100.00	107.17	111.89	102.12	89.01	67.04	75.29	72.92
14	Computed Value /Expected Values (E)	111.37	105.46	99.55	93.64	87.72	81.81	75.90	69.98
15	Chi-Square $(O-E)^2/E$	1.1615	0.0277	1.5302	0.7688	0.0190	2.6675	0.0049	0.1228

Average Overhead Productivity Indices= 90.68, a= 90.68, b= -2.96, χ^2 = 6.302, S.D. = 16.02, C.V. = 17.67 %.

Analysis and Interpretation

Output: The revalued output of Bharat Petroleum Corporation Ltd. portrays a choppy trend. It is the highest ₹ 211751.09 crore in 2013-14 and it is the lowest ₹ 151243.98 crore in 2010-11.

Power and Fuel: It is regarded as the most important element of overhead input. It is ₹ 475.89 crore in 2010-11 and reached to ₹ 1646.28 crore on 2017-18. Its input output ratio is the highest 0.0099 in 2015-16 while it is the lowest 0.0031 in 2010-11. The lowest power and fuel input output ratio conveys optimum utilisation has been achieved in this year.

Depreciation and Amortisation: It is the lowest ₹ 1655.40 crore in 2010-11 while it is the highest ₹ 2648.48 crore in 2017-18. Its input output ratio is the lowest 0.0093 in 2012-13 as compared to the highest 0.0138 in 2017-18.

Repairs and Maintenance: It is ₹ 537.51 crore in 2010-11 while it reached to ₹ 875.35 crore in 2017-18. Input output ratio of repairs and maintenance is the lowest 0.0030 in 2011-12 presenting optimum utilisation while it is the highest 0.0048 in 2016-17.

Business Service Input: It is the highest 8740.20 crore in 2017-18 while it is the lowest 5342.97 crore in 2010-11. Its input output ratio is the minimum 0.0311 in 2012-13 while it is the maximum 0.0529 in 2015-16.

Total Overhead: Total overhead input is ₹ 8011.77 crore in 2010-11 and reached to ₹ 13910.31 crore in 2017-18. Its input output ratio is the highest 0.0790 in 2015-16 while it is the lowest 0.0473 in 2012-13. The lowest overhead input output ratio means overhead has been best utilized in the year 2012-13.

Overhead Productivity Ratio: There is an erratic trend in the overhead productivity ratios of Bharat Petroleum Corporation Ltd. Overhead productivity ratio is the lowest 12.6552 in 2015-16 while it is the highest 21.1224 in 2012-13. The highest ratio reflects efficiency and effectiveness while the lowest ratio reflects that the overhead input has not been utilized efficiently as compared to the others. Improvement in overhead efficiency can also be observed from the average of overhead indices which worked out to 90.68 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: In Bharat Petroleum Corporation Ltd. the standard deviation calculated is 16.02 and coefficient of variation is 17.67 % indicates less variability. The computed value of chi-square is 6.302 while the table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the overhead productivity indices of the company for the study period are approximately equal and can be represented by straight line trend or line of best fit.

Table 6.22

Overhead Productivity of Hindustan Petroleum Corporation Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	131403.70	163897.08	179216.63	182515.82	170937.91	151402.12	151501.59	177367.29
2	Power and Fuel (₹ in Crore)	339.56	455.60	519.81	83.77	137.67	233.34	139.18	333.45
3	Power and Fuel (Input Output Ratio)	0.0026	0.0028	0.0029	0.0005	0.0008	0.0015	0.0009	0.0019
4	Depreciation and Amortisation (₹ in Crore)	1406.95	1712.93	1983.52	2201.94	1978.76	2659.44	2535.28	2752.75
5	Depreciation and Amortisation (Input Output Ratio)	0.0107	0.0105	0.0111	0.0121	0.0116	0.0176	0.0167	0.0155
6	Repairs and Maintenance (₹ in Crore)	648.82	628.93	698.31	718.64	840.43	940.63	995.81	1088.85
7	Repairs and Maintenance (Input Output Ratio)	0.0049	0.0038	0.0039	0.0039	0.0049	0.0062	0.0066	0.0061
8	Business Service Input (₹ in Crore)	4640.11	5241.45	5668.03	6614.57	6616.61	9064.27	6948.09	7505.89
9	Business Service Input (Input Output Ratio)	0.0353	0.0320	0.0316	0.0362	0.0387	0.0599	0.0459	0.0423
10	Total Overhead Input (₹ in Crore)	7035.44	8038.91	8869.66	9618.92	9573.47	12897.69	10618.35	11680.94
11	Total Overhead (Input Output Ratio)	0.0535	0.0490	0.0495	0.0527	0.0560	0.0852	0.0701	0.0659
12	Overhead Productivity Ratio	18.6774	20.3880	20.2056	18.9747	17.8554	11.7387	14.2679	15.1843
13	Overhead Productivity Indices /Observed Indices (O)	100.00	109.16	108.18	101.59	95.60	62.85	76.39	81.30
14	Computed Value /Expected Values (E)	110.08	104.88	99.68	94.48	89.28	84.08	78.89	73.69
15	Chi-Square $(O-E)^2/E$	0.9232	0.1744	0.7247	0.5348	0.4466	5.3628	0.0789	0.7863

Average Overhead Productivity Indices= 91.88, a= 91.88, b= - 2.60, χ^2 = 9.032, S.D. = 15.54, C.V. = 16.92%.

Analysis and Interpretation

Output: The revalued output of Hindustan Petroleum Corporation Ltd. is ₹ 131403.70 crore in 2010-11 and reached to ₹ 177367.29 crore in 2017-18.

Power and Fuel: It is the highest ₹ 519.81 crore in 2012-13 and the lowest ₹ 83.77 crore in 2013-14. Its input output ratio is the highest 0.0029 in 2012-13 while it is the lowest 0.0005 in 2013-14.

Depreciation and Amortisation: Depreciation and amortisation aspect of overhead input is the highest ₹ 2659.44 crore in 2015-16 while it is the lowest ₹ 1406.95 crore in 2010-11. Input output ratio of depreciation and amortisation is the lowest 0.0105 in 2011-12 while it is the highest 0.0176 in 2015-16.

Repairs and Maintenance: It is the lowest in ₹ 628.93 crore in 2011-12 as compared to the highest ₹ 1088.85 crore in 2017-18. Input output ratio lies between 0.0038 and 0.0066.

Business Service Input: Business service input is depicting an increasing trend till 2015-16 with ₹ 9064.27 crore. It slowed down in the year 2016-17 and again it increased and reached to ₹ 7505.89 crore in 2017-18. Its input output ratio is the minimum 0.0316 in 2012-13 while it is the maximum 0.0599 in 2015-16.

Total Overhead: Total overhead input consumption is ₹ 7035.44 crore in 2010-11 then it is increased and reached to ₹ 9618.92 crore in 2013-14, then it decreased to ₹ 9573.47 crore in 2014-15, again faced a fluctuation and ultimately reached to ₹ 11680.94 crore in 2017-18. Total overhead input output ratio is the highest 0.0852 in 2015-16 while it is the lowest 0.0490 in 2011-12.

Overhead Productivity Ratio: Overhead productivity ratio of Hindustan Petroleum Corporation Ltd. is the lowest 11.7387 in 2015-16 while it is the highest 20.3880 in 2011-12. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overhead input has not been utilized efficiently and mismanagement is responsible for low productivity. Overhead efficiency can also be observed from the average of overhead indices which worked out as 91.88 as compared to the base year index of 100. This highlights that overhead is not being able to utilize efficiently as compared to the base year.

Testing Hypothesis and Interpretation: Standard deviation of Hindustan Petroleum Corporation Ltd. is 15.54 while its coefficient of variation is 16.92 % indicated approx. 17 % of variability. The computed value of chi-square is 9.032. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the overhead productivity indices of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 6.23

Overhead Productivity of Indian Oil Corporation Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	326553.94	399196.39	382590.88	387987.09	362608.32	298354.22	287130.68	343394.88
2	Power and Fuel (₹ in Crore)	1880.24	3337.93	4362.76	4753.67	4990.81	4672.38	3987.81	4494.69
3	Power and Fuel (Input Output Ratio)	0.0058	0.0084	0.0114	0.0123	0.0138	0.0157	0.0139	0.0131
4	Depreciation and Amortisation (₹ in Crore)	4546.67	4867.79	5200.99	5760.09	4528.66	4852.79	6222.97	7067.01
5	Depreciation and Amortisation (Input Output Ratio)	0.0139	0.0122	0.0136	0.0148	0.0125	0.0163	0.0217	0.0206
6	Repairs and Maintenance (₹ in Crore)	1468.63	1574.51	1738.07	2040.16	2247.67	2631.88	2468.47	2912.12
7	Repairs and Maintenance (Input Output Ratio)	0.0045	0.0039	0.0045	0.0053	0.0062	0.0088	0.0086	0.0085
8	Business Service Input (₹ in Crore)	10540.88	12883.74	12467.08	15032.50	14765.81	19969.46	21469.18	16571.00
9	Business Service Input (Input Output Ratio)	0.0323	0.0323	0.0326	0.0387	0.0407	0.0669	0.0748	0.0483
10	Total Overhead Input (₹ in Crore)	18436.42	22663.97	23768.90	27586.42	26532.94	32126.51	34148.43	31044.81
11	Total Overhead (Input Output Ratio)	0.0565	0.0568	0.0621	0.0711	0.0732	0.1077	0.1189	0.0904
12	Overhead Productivity Ratio	17.7124	17.6137	16.0963	14.0644	13.6663	9.2869	8.4083	11.0613
13	Overhead Productivity Indices /Observed Indices (O)	100.00	99.44	90.88	79.40	77.16	52.43	47.47	62.45
14	Computed Value /Expected Values (E)	102.83	95.21	87.59	79.97	72.34	64.72	57.10	49.47
15	Chi-Square $(O-E)^2/E$	0.0780	0.1881	0.1234	0.0039	0.3204	2.3333	1.6229	3.4023

Average Overhead Productivity Indices= 76.15, a= 76.15, b =-3.81, χ^2 =8.072, S.D. = 19.08, C.V. = 25.06%.

Analysis and Interpretation

Output: The output of Indian Oil Corporation Ltd. exhibits an inconstant trend. It is ₹ 326553.94 crore in 2010-11, ₹ 399196.39 crore in 2011-12, ₹ 382590.88 crore in 2012-13, ₹ 387987.09 crore in 2013-14, ₹ 362608.32 in 2014-15, ₹ 298354.22 crore in 2015-16, ₹ 287130.68 crore in 2016-17 and ₹ 343394.88 crore in 2017-18.

Power and Fuel: Power and fuel element of overhead input is the lowest ₹ 1880.24 crore in 2010-11 while it is the highest ₹ 4990.81 crore in 2014-15. Its input output ratio is the highest 0.0157 in 2015-16 while it is the lowest 0.0058 in 2010-11. The lowest power and fuel input output ratio exhibits optimum utilisation has been achieved in this year.

Depreciation and Amortisation: Its consumption is the highest ₹ 7067.01 crore in 2017-18 while it is the lowest ₹ 4528.66 crore in 2014-15. Its input output ratio is the lowest 0.0122 in 2011-12 as compared to the highest 0.0217 in 2016-17.

Repairs and Maintenance: Repair and maintenance is the maximum ₹ 2912.12 crore in 2017-18 while it is the minimum ₹ 1468.63 crore in 2010-11. Its input output ratio is the lowest 0.0039 in 2011-12 while it is the highest 0.0088 in 2015-16.

Business Service Input: It is the lowest ₹ 10540.88 crore in 2010-11 while it is the highest ₹ 21469.18 crore in 2016-17. Its input output ratio is the lowest 0.0323 in 2010-11 and 2011-12 while it is the highest 0.0748 in 2016-17.

Total Overhead: Total overhead input of Indian Oil Corporation Ltd. is ₹ 18436.42 crore in 2010-11 and reached to ₹ 31044.81 crore in 2017-18. Total overhead input output ratio is the highest 0.1189 in 2016-17 while it is the lowest 0.0565 in 2010-11. The lowest overhead input output ratio means overhead has been best utilized in the year 2010-11.

Overhead Productivity Ratio: Overhead productivity ratio of Indian Oil Corporation Ltd. is the lowest 8.4083 in 2016-17 while it is the highest 17.7124 in 2010-11. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overhead input has not been utilized efficiently. Improvement in overhead efficiency can also be observed from the average of overhead indices which is 76.15 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Indian Oil Corporation Ltd. is 19.08 with 25.06 % of variability. The computed value of chi-square is 8.072 as compared to the table value 14.067 at 5% level of significance with (8-1) = 7 degree of freedom. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the overhead productivity indices of the Indian Oil Corporation Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 6.24

Overhead Productivity of Reliance Industries Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	247978.66	307735.63	313516.10	325963.44	273830.44	204990.51	202371.59	235728.97
2	Power and Fuel (₹ in Crore)	2255.07	3594.53	5868.95	7767.05	10023.69	9874.33	10322.55	12764.67
3	Power and Fuel (Input Output Ratio)	0.0091	0.0117	0.0187	0.0238	0.0366	0.0482	0.0510	0.0541
4	Depreciation and Amortisation (₹ in Crore)	13607.58	11394.00	9465.00	8789.00	8488.00	9566.00	8465.00	9580.00
5	Depreciation and Amortisation (Input Output Ratio)	0.0549	0.0370	0.0302	0.0270	0.0310	0.0467	0.0418	0.0406
6	Repairs and Maintenance (₹ in Crore)	904.05	941.87	820.35	853.54	1014.75	1160.92	1199.93	1333.53
7	Repairs and Maintenance (Input Output Ratio)	0.0036	0.0031	0.0026	0.0026	0.0037	0.0057	0.0059	0.0057
8	Business Service Input (₹ in Crore)	9427.82	8664.08	9383.72	8140.42	8425.12	9782.86	10797.76	8697.91
9	Business Service Input (Input Output Ratio)	0.0380	0.0282	0.0299	0.0250	0.0308	0.0477	0.0534	0.0369
10	Total Overhead Input (₹ in Crore)	26194.52	24594.48	25538.02	25550.00	27951.56	30384.11	30785.24	32376.11
11	Total Overhead (Input Output Ratio)	0.1056	0.0799	0.0815	0.0784	0.1021	0.1482	0.1521	0.1373
12	Overhead Productivity Ratio	9.4668	12.5124	12.2764	12.7579	9.7966	6.7466	6.5737	7.2810
13	Overhead Productivity Indices /Observed Indices (O)	100.00	132.17	129.68	134.76	103.48	71.27	69.44	76.91
14	Computed Value /Expected Values (E)	130.62	122.51	114.39	106.27	98.16	90.04	81.92	73.81
15	Chi-Square $(O-E)^2/E$	7.1791	0.7625	2.0436	7.6386	0.2892	3.9141	1.9022	0.1306

Average Overhead Productivity Indices=102.21, a=102.21, b= -4.06, χ^2= 23.860, S.D.= 25.96, C.V.= 25.39%.

Analysis and Interpretation

Output: The revalued output of Reliance Industries Ltd. is the highest ₹ 325963.44 crore in 2013-14 while it is the lowest ₹ 202371.59 crore in 2016-17.

Power and Fuel: It is the highest ₹ 12764.67 crore in 2017-18 and the lowest ₹ 2255.07 crore in 2010-11. Its input output ratio is showing an increasing trend. It is 0.0091 in 2010-11 and reached to 0.0541 in 2017-18.

Depreciation and Amortisation: Depreciation and amortisation is the highest ₹ 13607.58 crore in 2010-11 while it is the lowest ₹ 8465.00 crore in 2016-17. Input output ratio of depreciation and amortisation is the lowest 0.0270 in 2013-14 as compared to the highest 0.0549 in 2010-11.

Repairs and Maintenance: It is the lowest ₹ 820.35 crore in 2012-13 as compared to the highest ₹ 1333.53 crore in 2017-18. Input output ratio is the lowest 0.0026 in 2012-13 and 2013-14 while it is the highest 0.0059 in 2016-17.

Business Service Input: Business service input lies between ₹ 8140.42 crore and ₹ 10797.76 crore. Its input output ratio lies between 0.0250 and 0.0534.

Total Overhead: Total overhead input consumption of Reliance Industries Ltd. is ₹ 26194.52 crore in 2010-11, ₹ 24594.48 crore in 2011-12, ₹ 25538.02 crore in 2012-13, ₹ 25550.00 crore in 2013-14, ₹ 27951.56 crore in 2014-15, ₹ 30384.11 crore in 2015-16, ₹ 30785.24 crore in 2016-17 and ₹ 32376.11 crore in 2017-18. Total overhead input output ratio is the highest 0.1521 in 2016-17 while it is the

lowest 0.0784 in 2013-14. The lowest overhead input output ratio means total overhead is best utilized in the year 2013-14.

Overhead Productivity Ratio: Overhead productivity ratio is the lowest 6.5737 in 2016-17 while it is the highest 12.7579 in 2013-14. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overhead input has not been utilized efficiently. Overhead efficiency can also be analysed from the average of overhead indices. It is 102.21 which are slight higher than the base year index of 100. This indicates that on an average overhead is utilized efficiently in all the years.

Testing Hypothesis and Interpretation: The standard deviation of Reliance Industries Ltd. is 25.96 with coefficient of variation 25.39 %. The computed value of chi-square of is 23.860. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This reveals that the overhead productivity indices of the Reliance Industries Ltd. for the study period are not same and cannot be represented by straight line trend or line of best fit.

6.4. Overhead Productivity Ratios and Kruskal Wallis One Way Analysis of Variance Test

To study the inter-company relationship, second hypothesis has been framed. In this part, the hypothesis has been tested with the help of Kruskal Wallis One Way Analysis of Variance test. For this purpose the overhead productivity of all the sample companies is combined and arranged in order of increasing size and given a rank number. Where the tie occur the mean of the available rank numbers is used. The rank sum of each of the sample has been calculated. The detailed calculation has been done in the following tables from table 6.25 to 6.30.

Table 6.25

Comparative Overhead Productivity Ratios from 2010-11 to 2017-18 of Automobile Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	Bajaj Auto Ltd.		Mahindra & Mahindra Ltd.		Maruti Suzuki India Ltd.		Tata Motors Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	22.1194	32	9.1631	22	7.6346	19	6.9377	16
2011-12	21.3909	31	9.4994	23	6.8966	14	6.2322	13
2012-13	18.5469	30	10.0127	24	5.7791	10	5.3733	8
2013-14	16.5325	29	8.1045	21	5.4053	9	4.5706	4
2014-15	13.5236	27	7.8743	20	5.3182	7	3.6598	1
2015-16	12.5603	25	7.3804	18	5.1769	6	4.4624	3
2016-17	13.0388	26	7.0031	17	5.9893	11	4.0952	2
2017-18	13.7616	28	6.9314	15	6.1879	12	5.0214	5
Total		228		160		88		52

H = 26.045

Hypothesis Testing and Interpretation: The calculated value of H is 26.045 and the table value is 7.815 at 5 % level of significance with 4 – 1 = 3 degrees of freedom. As the calculated value is greater than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that the overhead productivity ratios of the automobile sector companies included in Nifty 50 are not same and there is a difference in the overhead productivity ratios.

Table 6.26

Comparative Overhead Productivity Ratios from 2010-11 to 2017-18 of Energy Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	GAIL (India) Ltd.		NTPC Ltd.		Oil and Natural Gas Corporation Ltd.		Power Grid Corporation of India Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	10.6934	32	7.7781	21	2.0755	8	3.1394	16
2011-12	9.8729	28	9.8808	29	2.0334	7	2.9886	15
2012-13	10.1619	30	8.5021	24	1.9090	5	2.7951	14
2013-14	10.5072	31	7.8393	22	1.9303	6	2.6194	13
2014-15	8.8859	26	6.8713	20	1.6564	1	2.3195	10
2015-16	8.6538	25	5.7976	18	1.7819	2	2.3759	11
2016-17	8.3783	23	6.3938	19	1.8790	4	2.3957	12
2017-18	8.9976	27	5.1839	17	1.8183	3	2.2586	9
Total		222		170		36		100

H = 28.102

Testing Hypothesis and Interpretation: The calculated value of H is 28.102 and the table value is 7.815 at 5 % level of significance with 4 - 1 = 3 degrees of freedom. As the calculated value is more than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that there is a significant difference in the overhead productivity ratios of the energy sector companies included in Nifty 50.

Table 6.27

Comparative Overhead Productivity Ratios from 2010-11 to 2017-18 of Information Technology Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	Infosys Ltd.		Tata Consultancy Services Ltd.		Tech Mahindra Ltd.		Wipro Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	5.5623	27	2.7462	9	2.2840	5	4.1923	22
2011-12	5.6613	28	2.9470	13	2.2883	6	3.9227	18
2012-13	6.3347	32	2.8252	10	2.3725	7	4.0574	20
2013-14	5.9684	30	2.9565	14	2.6068	8	4.1837	21
2014-15	6.0717	31	2.9065	11	2.0774	4	4.0574	19
2015-16	5.5295	26	2.9114	12	2.0395	3	3.7363	17
2016-17	5.4069	24	5.5124	25	1.9189	1	3.6034	16
2017-18	5.2056	23	5.6971	29	2.0318	2	3.4380	15
Total		221		123		36		148

H = 24.821

Hypothesis Testing and Interpretation: The calculated value of H is 24.821 and the table value is 7.815 at 5 % level of significance with 4 – 1 = 3 degrees of freedom. As the calculated value is greater than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that the overhead productivity ratios of the information technology sector companies included in Nifty 50 are not same that is there is a difference in the overhead productivity ratios.

Table 6.28

Comparative Overhead Productivity Ratios from 2010-11 to 2017-18 of Metals Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	Coal India Ltd.		Hindalco Ltd.		Tata Steel Ltd.		Vedanta Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	18.1155	25	5.5241	24	3.4776	16	3.6002	17
2011-12	46.7489	31	5.5207	23	3.1650	12	2.7352	6
2012-13	31.2503	26	4.9602	22	2.8814	8	1.4760	1
2013-14	42.6788	29	4.5813	21	2.7916	7	3.4470	14
2014-15	53.6250	32	4.0063	18	2.6215	5	4.4522	20
2015-16	45.3596	30	2.9363	10	2.5889	3	4.4073	19
2016-17	36.7608	28	2.9054	9	1.9405	2	3.4632	15
2017-18	32.0602	27	3.3356	13	2.6131	4	3.1616	11
Total		228		140		57		103

H = 22.366

Testing Hypothesis and Interpretation: The calculated value of H is 22.366 and the table value is 7.815 at 5 % level of significance with 4 - 1 = 3 degrees of freedom. As the calculated value is more than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that there is a significant difference in the overhead productivity ratios of the metals sector companies.

Table 6.29

Comparative Overhead Productivity Ratios from 2010-11 to 2017-18 of Pharmaceutical Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	Cipla Ltd.		Dr. Reddy's Laboratories Ltd.		Lupin Ltd.		Sun Pharmaceutical Industries Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	3.4043	19	2.6790	10	3.6727	26	4.7150	31
2011-12	3.5574	23	2.5503	7	3.4365	20	5.0683	32
2012-13	3.5279	21	2.8346	13	3.5814	24	3.7286	27
2013-14	3.5913	25	2.6623	8	4.1766	30	2.1245	2
2014-15	3.1634	15	2.8195	12	4.0555	29	2.1082	1
2015-16	3.3393	18	2.4328	5	4.0334	28	2.1446	3
2016-17	2.7062	11	2.5144	6	3.5393	22	2.6704	9
2017-18	2.9710	14	2.3376	4	3.1717	16	3.2386	17
Total		146		65		195		122

H = 12.435

Testing Hypothesis and Interpretation: The calculated value of H is 12.435 and the table value is 7.815 at 5 % level of significance with 4 - 1 = 3 degrees of freedom. As the calculated value is more than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that the overhead productivity ratios of the pharmaceutical sector companies included in Nifty 50 are not same that is there is a significant difference in overhead productivity.

Table 6.30

Comparative Overhead Productivity Ratios from 2010-11 to 2017-18 of Refineries Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	Bharat Petroleum Corporation Ltd.		Hindustan Petroleum Corporation Ltd.		Indian Oil Corporation Ltd.		Reliance Industries Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	18.8777	26	18.6774	25	17.7124	23	9.4668	6
2011-12	20.2313	30	20.3880	31	17.6137	22	12.5124	11
2012-13	21.1224	32	20.2056	29	16.0963	20	12.2764	10
2013-14	19.2779	28	18.9747	27	14.0644	16	12.7579	13
2014-15	16.8037	21	17.8554	24	13.6663	14	9.7966	7
2015-16	12.6552	12	11.7387	9	9.2869	5	6.7466	2
2016-17	14.2123	17	14.2679	18	8.4083	4	6.5737	1
2017-18	13.7650	15	15.1843	19	11.0613	8	7.2810	3
Total		181		182		112		53

H = 16.395

Testing Hypothesis and Interpretation: The calculated value of H is 16.395 and the table value is 7.815 at 5 % level of significance with 4 - 1 = 3 degrees of freedom. As the calculated value is more than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that there is a significant difference in overhead productivity ratios of the refineries sector companies included in Nifty 50.

6.5. Possible Savings

Possible savings has been calculated to analyse what would have been saved if optimum utilisation of overhead input is made. Possible savings in overhead input for all six sectors are being detailed here.

6.5.1. Possible Savings in Overhead Input of Automobile Sector Companies

Possible savings in overhead input has been calculated to analyse what would have been saved if the overhead input is optimally utilized. To improve the performance of the companies in respect of the overhead input an attempt has been made to calculate the possible savings. Total possible savings comprises of four parts viz., power and fuel, depreciation and amortisation, repairs and maintenance and business service input.

Table 6.31

Possible Savings in Overhead Input of Automobile Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bajaj Auto Ltd.	Mahindra & Mahindra Ltd.	Maruti Suzuki India Ltd.	Tata Motors Ltd.
2010-11	Standard	764	2367	4856	6797
	Actual	764	2586	4856	6797
	Saving	**0**	**219**	**0**	**0**
2011-12	Standard	832	2909	4363	7177
	Actual	860	3066	4830	7992
	Saving	**28**	**157**	**467**	**815**
2012-13	Standard	808	3510	4999	5782
	Actual	964	3510	6603	7467
	Saving	**156**	**0**	**1604**	**1685**
2013-14	Standard	769	3338	4761	4526
	Actual	1028	4123	6724	6872
	Saving	**259**	**785**	**1963**	**2346**
2014-15	Standard	806	3190	5316	4333
	Actual	1319	4055	7630	8215
	Saving	**513**	**865**	**2314**	**3882**
2015-16	Standard	895	3472	6383	5370
	Actual	1577	4709	9412	8352
	Saving	**682**	**1237**	**3029**	**2982**
2016-17	Standard	854	3737	7542	5342
	Actual	1448	5342	9613	9053
	Saving	**594**	**1605**	**2071**	**3711**
2017-18	Standard	958	3984	8567	7050
	Actual	1540	5754	10569	9743
	Saving	**582**	**1770**	**2002**	**2693**
Total Savings		2815	6637	13449	18114

Note: Amount has been rounded off to nearest ₹

Table 6.31 suggests that total possible savings in overhead input for a period of eight years would have been ₹ 2815 crore of Bajaj Auto Ltd., ₹ 6637 crore of Mahindra & Mahindra Ltd., ₹ 13449 crore of Maruti Suzuki India Ltd. and lastly ₹ 18114 crore of Tata Motors Ltd.

1. Possible Savings in Power and Fuel

The most important aspect of overhead input is Power and Fuel. For analyzing this possible savings has been calculated and results has been analysed.

Table 6.32

Possible Savings in Power and Fuel of Automobile Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bajaj Auto Ltd.	Mahindra & Mahindra Ltd.	Maruti Suzuki India Ltd.	Tata Motors Ltd.
2010-11	Standard	76	114	210	448
	Actual	87	144	210	471
	Saving	**11**	**30**	**0**	**23**
2011-12	Standard	83	140	190	473
	Actual	89	154	202	484
	Saving	**6**	**14**	**12**	**11**
2012-13	Standard	80	169	218	381
	Actual	99	169	404	397
	Saving	**19**	**0**	**186**	**16**
2013-14	Standard	77	160	207	300
	Actual	81	169	454	300
	Saving	**4**	**9**	**247**	**0**
2014-15	Standard	80	153	231	286
	Actual	93	181	581	323
	Saving	**13**	**28**	**350**	**37**
2015-16	Standard	89	167	278	354
	Actual	122	234	702	408
	Saving	**33**	**67**	**424**	**54**
2016-17	Standard	85	180	328	352
	Actual	98	234	526	492
	Saving	**13**	**54**	**198**	**140**
2017-18	Standard	94	191	373	465
	Actual	94	233	632	513
	Saving	**0**	**42**	**259**	**48**
Total Savings		99	244	1676	329

Note: Amount has been rounded off to nearest ₹

Table 6.32 displays that total possible savings in power and fuel for a period of eight years would have been ₹ 99 crore of Bajaj Auto Ltd. which is ₹ 12.38 per annum, ₹ 244 crore of Mahindra & Mahindra Ltd., ₹ 1676 crore of Maruti Suzuki India Ltd. and lastly ₹ 329 crore of Tata Motors Ltd.

2. Possible Savings in Depreciation and Amortisation

Possible savings in depreciation and amortisation component of overhead input exhibits below:

Table 6.33

Possible Savings in Depreciation and Amortisation of Automobile Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bajaj Auto Ltd.	Mahindra & Mahindra Ltd.	Maruti Suzuki India Ltd.	Tata Motors Ltd.
2010-11	Standard	123	414	1014	1361
	Actual	123	414	1014	1361
	Saving	**0**	**0**	**0**	**0**
2011-12	Standard	134	510	909	1439
	Actual	146	576	1138	1607
	Saving	**12**	**66**	**229**	**168**
2012-13	Standard	131	615	1042	1160
	Actual	167	711	1861	1818
	Saving	**36**	**96**	**819**	**658**
2013-14	Standard	124	585	992	908
	Actual	180	863	2084	2070
	Saving	**56**	**278**	**1092**	**1162**
2014-15	Standard	130	559	1108	869
	Actual	267	975	2470	2603
	Saving	**137**	**416**	**1362**	**1734**
2015-16	Standard	145	608	1330	1077
	Actual	307	1109	2824	2454
	Saving	**162**	**501**	**1494**	**1377**
2016-17	Standard	138	655	1572	1071
	Actual	307	1526	2602	3037
	Saving	**169**	**871**	**1030**	**1966**
2017-18	Standard	155	698	1785	1414
	Actual	315	1479	2758	3102
	Saving	**160**	**781**	**973**	**1688**
Total Savings		732	3010	6999	8753

Note: Amount has been rounded off to nearest ₹

Table 6.33 reveals that total possible savings in depreciation and amortization segment for the period of Bajaj Auto Ltd. would have been ₹ 732 crore with base year 2010-11, Mahindra & Mahindra Ltd. ₹ 3010 crore with 2010-11 as the base year, Maruti Suzuki India Ltd. ₹ 6999 crore with base year 2010-11 and lastly Tata Motors Ltd. ₹ 8753 crore with base year 2010-11.

3. **Possible Savings in Repairs and Maintenance**

Repairs and maintenance segment's possible savings has been detailed below:

Table 6.34

Possible Savings in Repairs and Maintenance of Automobile Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bajaj Auto Ltd.	Mahindra & Mahindra Ltd.	Maruti Suzuki India Ltd.	Tata Motors Ltd.
2010-11	Standard	80	142	85	128
	Actual	80	162	85	128
	Saving	**0**	**20**	**0**	**0**
2011-12	Standard	86	175	77	134
	Actual	94	198	83	161
	Saving	**8**	**23**	**6**	**27**
2012-13	Standard	84	210	88	108
	Actual	112	210	128	161
	Saving	**28**	**0**	**40**	**53**
2013-14	Standard	80	201	84	85
	Actual	118	234	148	117
	Saving	**38**	**33**	**64**	**32**
2014-15	Standard	84	192	93	81
	Actual	161	246	156	134
	Saving	**77**	**54**	**63**	**53**
2015-16	Standard	93	209	112	101
	Actual	170	300	229	132
	Saving	**77**	**91**	**117**	**31**
2016-17	Standard	89	224	132	0
	Actual	155	289	216	0
	Saving	**66**	**65**	**84**	**0**
2017-18	Standard	100	239	150	0
	Actual	130	311	259	0
	Saving	**30**	**72**	**109**	**0**
Total Savings		324	359	483	196

Note: Amount has been rounded off to nearest ₹

Table 6.34 suggests that Maruti Suzuki India Ltd. would have saved ₹ 483 crore, Mahindra & Mahindra Ltd. ₹ 359 crore, Bajaj Auto Ltd. ₹ 324 crore and lastly ₹ 196 crore would be possible savings of Tata Motors Ltd. for the study period if its input is fully utilized.

4. Possible Savings in Business Service Input

Last but not the least possible savings in business service input have been calculated stated as below:

Table 6.35

Possible Savings in Business Service Input of Automobile Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bajaj Auto Ltd.	Mahindra & Mahindra Ltd.	Maruti Suzuki India Ltd.	Tata Motors Ltd.
2010-11	Standard	475	1632	3547	4837
	Actual	475	1866	3547	4837
	Saving	**0**	**234**	**0**	**0**
2011-12	Standard	517	2006	3188	5110
	Actual	531	2137	3407	5740
	Saving	**14**	**131**	**219**	**630**
2012-13	Standard	502	2420	3652	4117
	Actual	586	2420	4210	5092
	Saving	**84**	**0**	**558**	**975**
2013-14	Standard	478	2302	3478	3223
	Actual	650	2857	4037	4385
	Saving	**172**	**555**	**559**	**1162**
2014-15	Standard	501	2200	3883	3085
	Actual	797	2653	4424	5155
	Saving	**296**	**453**	**541**	**2070**
2015-16	Standard	557	2395	4663	3824
	Actual	978	3067	5657	5358
	Saving	**421**	**672**	**994**	**1534**
2016-17	Standard	531	2578	5510	3804
	Actual	888	3293	6269	5524
	Saving	**357**	**715**	**759**	**1720**
2017-18	Standard	595	2748	6259	5020
	Actual	1000	3731	6919	6128
	Saving	**405**	**983**	**660**	**1108**
Total Savings		1749	3742	4290	9201

Note: Amount has been rounded off to nearest ₹

Table 6.35 reveals that total possible savings in business service input for the period of eight years of Bajaj Auto Ltd. would have been ₹ 1749 crore with base year 2010-11. It is ₹ 3742 crore of Mahindra & Mahindra Ltd. which annually amounts to ₹ 468 crore approximately with 2012-13 as a base year. Annual savings of Maruti Suzuki India Ltd. would be ₹ 536 crore and calculating total savings for the study period amounts to ₹ 4290 crore with base year 2010-11. Lastly ₹ 9201 crore of savings may be possible of Tata Motors Ltd. which annually amounts to ₹ 1150 crore with base year 2010-11.

6.5.2. Possible Savings in Overhead Input of Energy Sector Companies

Table below highlights the possible savings in overhead input of energy sector companies including its parts viz., power and fuel, depreciation and amortisation, repairs and maintenance and business service input.

Table 6.36

Possible Savings in Overhead Input of Energy Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		GAIL (India) Ltd.	NTPC Ltd.	Oil and Natural Gas Corporation Ltd.	Power Grid Corporation of India Ltd.
2010-11	Standard	3072	5810	34562	2898
	Actual	3072	7381	34562	2898
	Saving	**0**	**1571**	**0**	**0**
2011-12	Standard	3462	6023	35771	3153
	Actual	3750	6023	36513	3313
	Saving	**288**	**0**	**742**	**160**
2012-13	Standard	3874	5979	36594	3647
	Actual	4077	6949	39787	4096
	Saving	**203**	**970**	**3193**	**449**
2013-14	Standard	4408	6169	35662	4086
	Actual	4487	7776	38345	4897
	Saving	**79**	**1607**	**2683**	**811**
2014-15	Standard	4359	6145	34200	4564
	Actual	5246	8837	42856	6178
	Saving	**887**	**2692**	**8656**	**1614**
2015-16	Standard	4162	6073	34108	5673
	Actual	5144	10351	39728	7497
	Saving	**982**	**4278**	**5620**	**1824**
2016-17	Standard	3799	6608	33883	6966
	Actual	4849	10213	37427	9130
	Saving	**1050**	**3605**	**3544**	**2164**
2017-18	Standard	4080	6890	35734	7829
	Actual	4850	13133	40790	10884
	Saving	**770**	**6243**	**5056**	**3055**
Total Savings		4260	20966	29495	10076

Note: Amount has been rounded off to nearest ₹

Table 6.36 suggests that the total possible savings in overhead input would have been ₹ 4260 crore of GAIL (India) Ltd., ₹ 20966 crore of NTPC Ltd., ₹ 29495 crore of Oil and Natural Gas Corporation Ltd. and lastly ₹ 10076 crore of Power Grid Corporation of India Ltd. For calculating possible savings year of the lowest overhead input output ratio has been taken as the base year.

1. Possible Savings in Power and Fuel

One of the chunks of overhead input is power and fuel. For analyzing this, possible savings has been calculated and results has been analysed.

Table 6.37

Possible Savings in Power and Fuel of Energy Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		GAIL (India) Ltd.	NTPC Ltd.	Oil and Natural Gas Corporation Ltd.	Power Grid Corporation of India Ltd.
2010-11	Standard	808	423	258	66
	Actual	973	423	286	72
	Saving	**165**	**0**	**28**	**6**
2011-12	Standard	911	440	267	71
	Actual	936	471	278	71
	Saving	**25**	**31**	**11**	**0**
2012-13	Standard	1018	437	274	82
	Actual	1018	527	274	87
	Saving	**0**	**90**	**0**	**5**
2013-14	Standard	1160	451	266	92
	Actual	1282	521	291	93
	Saving	**122**	**70**	**25**	**1**
2014-15	Standard	1147	449	256	103
	Actual	1579	534	318	139
	Saving	**432**	**85**	**62**	**36**
2015-16	Standard	1095	444	255	128
	Actual	2060	725	519	163
	Saving	**965**	**281**	**264**	**35**
2016-17	Standard	999	483	253	157
	Actual	1941	777	568	232
	Saving	**942**	**294**	**315**	**75**
2017-18	Standard	1073	504	267	177
	Actual	2012	1082	471	229
	Saving	**939**	**578**	**204**	**52**
Total Savings		3590	1428	908	208

Note: Amount has been rounded off to nearest ₹

Table 6.37 suggests that the total possible savings in power and fuel for a period of eight years would have been the lowest ₹ 208 crore of Power Grid Corporation of India Ltd. while it would have been the highest ₹ 3590 crore of GAIL (India) Ltd.

2. Possible Savings in Depreciation and Amortisation

The next important segment to discuss and analyse is depreciation and amortisation. Its possible savings have been stated below:

Table 6.38

Possible Savings in Depreciation and Amortisation of Energy Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		GAIL (India) Ltd.	NTPC Ltd.	Oil and Natural Gas Corporation Ltd.	Power Grid Corporation of India Ltd.
2010-11	Standard	650	2486	15926	2199
	Actual	650	2486	15926	2199
	Saving	**0**	**0**	**0**	**0**
2011-12	Standard	733	2577	16482	2393
	Actual	791	2792	16829	2573
	Saving	**58**	**215**	**347**	**180**
2012-13	Standard	820	2558	16861	2767
	Actual	981	3397	18414	3352
	Saving	**161**	**839**	**1553**	**585**
2013-14	Standard	934	2640	16432	3101
	Actual	1176	4142	18762	3996
	Saving	**242**	**1502**	**2330**	**895**
2014-15	Standard	923	2629	15759	3464
	Actual	974	4912	21981	5085
	Saving	**51**	**2283**	**6222**	**1621**
2015-16	Standard	881	2598	15716	4305
	Actual	1313	5425	17287	6183
	Saving	**432**	**2827**	**1571**	**1878**
2016-17	Standard	804	2827	15612	5287
	Actual	1397	5921	17244	7663
	Saving	**593**	**3094**	**1632**	**2376**
2017-18	Standard	864	2948	16465	5942
	Actual	1415	7099	21502	9091
	Saving	**551**	**4151**	**5037**	**3149**
Total Savings		2087	14911	18691	10685

Note: Amount has been rounded off to nearest ₹

Table 6.38 reveals and suggests that total possible savings in depreciation and amortisation share of overhead input for a period of eight years is of GAIL (India) Ltd. would have been ₹ 2087 crore, ₹ 10685 crore of Power Grid Corporation of India Ltd., ₹ 14911 crore of NTPC Ltd. and lastly ₹ 18691 crore of savings may be possible of Oil and Natural Gas Corporation Ltd.

3. **Possible Savings in Repairs and Maintenance**

Next important segment in overhead input is repairs and maintenance. Its possible savings has been detailed as under.

Table 6.39

Possible Savings in Repairs and Maintenance of Energy Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		GAIL (India) Ltd.	NTPC Ltd.	Oil and Natural Gas Corporation Ltd.	Power Grid Corporation of India Ltd.
2010-11	Standard	197	1495	624	174
	Actual	207	1495	887	188
	Saving	**10**	**0**	**263**	**14**
2011-12	Standard	222	1553	643	189
	Actual	230	1624	643	199
	Saving	**8**	**71**	**0**	**10**
2012-13	Standard	249	1542	661	219
	Actual	255	1678	761	219
	Saving	**6**	**136**	**100**	**0**
2013-14	Standard	284	1591	644	245
	Actual	284	1769	724	268
	Saving	**0**	**178**	**80**	**23**
2014-15	Standard	280	1585	618	274
	Actual	396	1903	843	340
	Saving	**116**	**318**	**225**	**66**
2015-16	Standard	267	1566	616	340
	Actual	410	2152	1227	399
	Saving	**143**	**586**	**611**	**59**
2016-17	Standard	244	1704	612	418
	Actual	360	1901	1053	470
	Saving	**116**	**197**	**441**	**52**
2017-18	Standard	262	1777	645	470
	Actual	305	2201	930	496
	Saving	**43**	**424**	**285**	**26**
Total Savings		443	1909	2006	251

Note: Amount has been rounded off to nearest ₹

Table 6.39 demonstrates ₹ 251 crore would be possible savings of Power Grid Corporation of India Ltd. if its input is optimally utilized. GAIL (India) Ltd. would have saved ₹ 443 crore, NTPC Ltd. would have saved ₹ 1909 crore and lastly Oil and Natural Gas Corporation Ltd. would have saved ₹ 2006 crore.

4. **Possible Savings in Business Service Input**

The substantial part of overhead input is business service input. Possible savings in this has been depicted as under:

Table 6.40

Possible Savings in Business Service Input of Energy Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		GAIL (India) Ltd.	NTPC Ltd.	Oil and Natural Gas Corporation Ltd.	Power Grid Corporation of India Ltd.
2010-11	Standard	841	1096	17302	318
	Actual	1242	2977	17464	438
	Saving	**401**	**1881**	**162**	**120**
2011-12	Standard	948	1137	17908	347
	Actual	1794	1137	18763	471
	Saving	**846**	**0**	**855**	**124**
2012-13	Standard	1061	1128	18320	401
	Actual	1823	1347	20335	439
	Saving	**762**	**219**	**2015**	**38**
2013-14	Standard	1207	1164	17853	449
	Actual	1745	1345	18568	541
	Saving	**538**	**181**	**715**	**92**
2014-15	Standard	1193	1160	17121	502
	Actual	2297	1488	19714	614
	Saving	**1104**	**328**	**2593**	**112**
2015-16	Standard	1140	1146	17075	623
	Actual	1361	2048	20695	752
	Saving	**221**	**902**	**3620**	**129**
2016-17	Standard	1040	1247	16963	766
	Actual	1152	1614	18562	766
	Saving	**112**	**367**	**1599**	**0**
2017-18	Standard	1118	1300	17887	860
	Actual	1118	2751	17887	1067
	Saving	**0**	**1451**	**0**	**207**
Total Savings		3985	5328	11559	822

Note: Amount has been rounded off to nearest ₹

Table 6.40 suggested that ₹ 822 crore would be possible savings of Power Grid Corporation of India Ltd. as compared to the highest possible savings ₹ 11559 crore of Oil and Natural Gas Corporation of India Ltd. if its input is optimally utilized.

6.5.3. Possible Savings in Overhead Input of Information Technology Sector Companies

Savings in overhead input along with its components such as power and fuel, depreciation and amortisation, repairs and maintenance and business service input has been discussed below.

Table 6.41

Possible Savings in Overhead Input of Information Technology Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Infosys Ltd.	Tata Consultancy Services Ltd.	Tech Mahindra Ltd.	Wipro Ltd.
2010-11	Standard	4189	5225	1953	6428
	Actual	4770	10841	2230	6428
	Saving	**581**	**5616**	**277**	**0**
2011-12	Standard	4866	6693	1870	7215
	Actual	5443	12941	2131	7712
	Saving	**577**	**6248**	**261**	**497**
2012-13	Standard	5297	7637	1946	7075
	Actual	5297	15402	2139	7311
	Saving	**0**	**7765**	**193**	**236**
2013-14	Standard	6045	9708	5123	7857
	Actual	6415	18709	5123	7874
	Saving	**370**	**9001**	**0**	**17**
2014-15	Standard	6444	11040	5963	8353
	Actual	6722	21642	7483	8632
	Saving	**278**	**10602**	**1520**	**279**
2015-16	Standard	7532	13162	7089	9463
	Actual	8627	25760	9061	10619
	Saving	**1095**	**12598**	**1972**	**1156**
2016-17	Standard	8103	14048	7595	9590
	Actual	9491	14521	10318	11159
	Saving	**1388**	**473**	**2723**	**1569**
2017-18	Standard	8322	14468	7783	9004
	Actual	10124	14468	9985	10980
	Saving	**1802**	**0**	**2202**	**1976**
Total Savings		6091	52304	9148	5731

Note: Amount has been rounded off to nearest ₹

Table 6.41 suggests that the total possible savings in overhead input for a period of eight years would have been ₹ 6091 crore of Infosys Ltd., ₹ 52304 crore of Tata Consultancy Services Ltd., ₹ 9148 crore of Tech Mahindra Ltd. and lastly ₹ 5731 crore of Wipro Ltd. For calculating possible savings year of the lowest overhead input output ratio has been taken as the base year.

1. Possible Savings in Power and Fuel

The table below analyses the possible savings in power and fuel component of overhead input.

Table 6.42

Possible Savings in Power and Fuel of Information Technology Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Infosys Ltd.	Tata Consultancy Services Ltd.	Tech Mahindra Ltd.	Wipro Ltd.
2010-11	Standard	77	191	32	151
	Actual	142	240	52	201
	Saving	**65**	**49**	**20**	**50**
2011-12	Standard	89	244	30	169
	Actual	135	256	48	205
	Saving	**46**	**12**	**18**	**36**
2012-13	Standard	97	278	31	166
	Actual	147	308	49	189
	Saving	**50**	**30**	**18**	**23**
2013-14	Standard	111	354	83	184
	Actual	138	354	92	189
	Saving	**27**	**0**	**9**	**5**
2014-15	Standard	118	402	97	198
	Actual	151	402	97	198
	Saving	**33**	**0**	**0**	**0**
2015-16	Standard	138	480	115	222
	Actual	182	518	131	253
	Saving	**44**	**38**	**16**	**31**
2016-17	Standard	149	0	123	0
	Actual	183	0	139	0
	Saving	**34**	**0**	**16**	**0**
2017-18	Standard	152	0	126	0
	Actual	152	0	128	0
	Saving	**0**	**0**	**2**	**0**
Total Savings		298	129	100	144

Note: Amount has been rounded off to nearest ₹

Table 6.42 presents that the lowest possible savings in power and fuel for a period of eight years would have been ₹ 100 crore of Tech Mahindra Ltd. while the highest possible savings in power and fuel would have been ₹ 298 crore of Infosys Ltd.

2. Possible Savings in Depreciation and Amortisation

Table 6.43 elaborates the possible savings in depreciation and amortisation component of overhead input.

Table 6.43

Possible Savings in Depreciation and Amortisation of Information Technology Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Infosys Ltd.	Tata Consultancy Services Ltd.	Tech Mahindra Ltd.	Wipro Ltd.
2010-11	Standard	594	536	138	590
	Actual	740	538	138	600
	Saving	**146**	**2**	**0**	**10**
2011-12	Standard	690	688	133	663
	Actual	794	688	151	746
	Saving	**104**	**0**	**18**	**83**
2012-13	Standard	752	783	138	650
	Actual	956	803	157	701
	Saving	**204**	**20**	**19**	**51**
2013-14	Standard	858	996	363	721
	Actual	1101	1081	427	737
	Saving	**243**	**85**	**64**	**16**
2014-15	Standard	913	1132	423	767
	Actual	913	1394	473	778
	Saving	**0**	**262**	**50**	**11**
2015-16	Standard	1069	1350	503	869
	Actual	1115	1559	546	869
	Saving	**46**	**209**	**43**	**0**
2016-17	Standard	1149	1441	539	881
	Actual	1331	1575	622	1048
	Saving	**182**	**134**	**83**	**167**
2017-18	Standard	1181	1484	552	827
	Actual	1408	1647	656	1015
	Saving	**227**	**163**	**104**	**188**
Total Savings		1153	875	382	527

Note: Amount has been rounded off to nearest ₹

Table 6.43 manifests the total possible savings in depreciation and amortisation component of overhead input for a period of eight years of Infosys Ltd. would have been ₹ 1153 crore, Tata Consultancy Services Ltd. ₹ 875 crore, Tech Mahindra Ltd. ₹ 382 crore and lastly Wipro Ltd. ₹ 527 crore.

3. **Possible Savings in Repairs and Maintenance**

Another aspect of overhead input is repairs and maintenance. For analyzing this, possible savings has been calculated and results has been analysed.

Table 6.44

Possible Savings in Repairs and Maintenance of Information Technology Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Infosys Ltd.	Tata Consultancy Services Ltd.	Tech Mahindra Ltd.	Wipro Ltd.
2010-11	Standard	223	158	44	11
	Actual	265	180	49	152
	Saving	**42**	**22**	**5**	**141**
2011-12	Standard	259	202	42	12
	Actual	285	202	47	419
	Saving	**26**	**0**	**5**	**407**
2012-13	Standard	282	231	44	12
	Actual	292	234	44	305
	Saving	**10**	**3**	**0**	**293**
2013-14	Standard	323	293	116	13
	Actual	323	330	122	326
	Saving	**0**	**37**	**6**	**313**
2014-15	Standard	343	333	135	14
	Actual	427	396	154	29
	Saving	**84**	**63**	**19**	**15**
2015-16	Standard	401	397	161	17
	Actual	630	530	186	17
	Saving	**229**	**133**	**25**	**0**
2016-17	Standard	431	0	172	0
	Actual	883	0	205	0
	Saving	**452**	**0**	**33**	**0**
2017-18	Standard	443	0	177	0
	Actual	721	0	199	0
	Saving	**278**	**0**	**22**	**0**
Total Savings		1122	257	114	1169

Note: Amount has been rounded off to nearest ₹

Table 6.44 indicates that ₹ 114 crore would be possible savings of Tech Mahindra Ltd. if its input is optimally utilized. Tata Consultancy Services Ltd. would also have saved ₹ 257 crore, followed by Infosys Ltd. with ₹ 1122 crore and lastly Wipro Ltd. with ₹ 1169 crore.

4. **Possible Savings in Business Service Input**

Possible savings in business service input has been stated below:

Table 6.45

Possible Savings in Business Service Input of Information Technology Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Infosys Ltd.	Tata Consultancy Services Ltd.	Tech Mahindra Ltd.	Wipro Ltd.
2010-11	Standard	3086	4629	1709	5417
	Actual	3623	9882	1990	5475
	Saving	**537**	**5253**	**281**	**58**
2011-12	Standard	3584	5930	1636	6081
	Actual	4229	11795	1885	6342
	Saving	**645**	**5865**	**249**	**261**
2012-13	Standard	3902	6766	1703	5963
	Actual	3902	14058	1889	6117
	Saving	**0**	**7292**	**186**	**154**
2013-14	Standard	4452	8601	4482	6623
	Actual	4852	16945	4482	6623
	Saving	**400**	**8344**	**0**	**0**
2014-15	Standard	4747	9782	5217	7040
	Actual	5231	19451	6759	7628
	Saving	**484**	**9669**	**1542**	**588**
2015-16	Standard	5548	11662	6202	7975
	Actual	6700	23153	8198	9481
	Saving	**1152**	**11491**	**1996**	**1506**
2016-17	Standard	5968	12447	6645	8082
	Actual	7093	12946	9352	10111
	Saving	**1125**	**499**	**2707**	**2029**
2017-18	Standard	6129	12821	6809	7588
	Actual	7843	12821	9002	9966
	Saving	**1714**	**0**	**2193**	**2378**
Total Savings		6057	48411	9155	6975

Note: Amount has been rounded off to nearest ₹

Table 6.45 depicts that the highest savings would have been possible of Tata Consultancy Services Ltd. with ₹ 48411 crore and the lowest possible savings amounts to ₹ 6057 crore of Infosys Ltd.

6.5.4. Possible Savings in Overhead Input of Metals Sector Companies

Possible savings in overhead input has been calculated to analyse what would have been saved if the overhead input is optimally utilized. To improve the performance of the companies in respect of the overhead input and its components, possible savings has been calculated.

Table 6.46

Possible Savings in Overhead Input of Metals Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Coal India Ltd.	Hindalco Ltd.	Tata Steel Ltd.	Vedanta Ltd.
2010-11	Standard	102	4311	8555	1796
	Actual	302	4311	8555	2221
	Saving	**200**	**0**	**0**	**425**
2011-12	Standard	163	4454	9135	1433
	Actual	187	4457	10035	2332
	Saving	**24**	**3**	**900**	**899**
2012-13	Standard	183	4224	9560	479
	Actual	315	4705	11536	1446
	Saving	**132**	**481**	**1976**	**967**
2013-14	Standard	249	4180	9937	5461
	Actual	313	5040	12377	7054
	Saving	**64**	**860**	**2440**	**1593**
2014-15	Standard	218	5175	9655	6295
	Actual	218	7137	12806	6295
	Saving	**0**	**1962**	**3151**	**0**
2015-16	Standard	268	5390	10169	7288
	Actual	317	10141	13657	7362
	Saving	**49**	**4751**	**3488**	**74**
2016-17	Standard	235	5488	12390	8494
	Actual	344	10436	22201	10920
	Saving	**109**	**4948**	**9811**	**2426**
2017-18	Standard	148	6266	14208	8861
	Actual	249	10378	18905	12479
	Saving	**101**	**4112**	**4697**	**3618**
Total Savings		680	17118	26463	10002

Note: Amount has been rounded off to nearest ₹

Table 6.46 indicates that total possible savings in overhead input for a period of eight years would have been ₹ 680 crore of Coal India Ltd., ₹ 10002 crore of Vedanta Ltd., ₹ 17118 crore of Hindalco Ltd. and lastly ₹ 26463 crore of Tata Steel Ltd.

1. Possible Savings in Power and Fuel

The essential component of overhead input is power and fuel. For detailing this possible savings has been calculated and results has been analysed.

Table 6.47

Possible Savings in Power and Fuel of Metals Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Coal India Ltd.	Hindalco Ltd.	Tata Steel Ltd.	Vedanta Ltd.
2010-11	Standard	2	2221	946	15
	Actual	6	2221	1146	15
	Saving	**4**	**0**	**200**	**0**
2011-12	Standard	4	2296	1011	12
	Actual	5	2520	1011	13
	Saving	**1**	**224**	**0**	**1**
2012-13	Standard	4	2177	1057	4
	Actual	6	2517	1343	457
	Saving	**2**	**340**	**286**	**453**
2013-14	Standard	5	2154	1099	46
	Actual	5	2722	1475	3575
	Saving	**0**	**568**	**376**	**3529**
2014-15	Standard	5	2668	1068	53
	Actual	7	4239	1628	3613
	Saving	**2**	**1571**	**560**	**3560**
2015-16	Standard	6	2778	1124	62
	Actual	11	6599	1960	4422
	Saving	**5**	**3821**	**836**	**4360**
2016-17	Standard	5	2829	1370	72
	Actual	12	5999	3602	4660
	Saving	**7**	**3170**	**2232**	**4588**
2017-18	Standard	3	3230	1571	75
	Actual	11	5646	3508	6251
	Saving	**8**	**2416**	**1937**	**6176**
Total Savings		29	12110	6427	22667

Note: Amount has been rounded off to nearest ₹

Table 6.47 unveils that total possible savings in power and fuel for a period of eight years would have been ₹ 29 crore of Coal India Ltd., ₹ 6427 crore of Tata Steel Ltd., ₹ 12110 crore of Hindalco Ltd. and lastly ₹ 22667 crore of Vedanta Ltd.

2. Possible Savings in Depreciation and Amortisation

Possible savings in depreciation and amortisation factor of overhead input has been discussed and analysed as below.

Table 6.48

Possible Savings in Depreciation and Amortisation of Metals Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Coal India Ltd.	Hindalco Ltd.	Tata Steel Ltd.	Vedanta Ltd.
2010-11	Standard	3	667	1558	83
	Actual	6	687	1558	83
	Saving	**3**	**20**	**0**	**0**
2011-12	Standard	4	690	1664	66
	Actual	7	690	1990	84
	Saving	**3**	**0**	**326**	**18**
2012-13	Standard	5	653	1742	22
	Actual	5	704	2510	148
	Saving	**0**	**51**	**768**	**126**
2013-14	Standard	6	647	1811	253
	Actual	6	823	2772	1505
	Saving	**0**	**176**	**961**	**1252**
2014-15	Standard	6	801	1759	291
	Actual	7	837	2704	1012
	Saving	**1**	**36**	**945**	**721**
2015-16	Standard	7	834	1853	337
	Actual	15	1277	2881	1218
	Saving	**8**	**443**	**1028**	**881**
2016-17	Standard	6	849	2257	393
	Actual	18	1428	2881	2986
	Saving	**12**	**579**	**624**	**2593**
2017-18	Standard	4	969	2589	410
	Actual	18	1617	2925	2842
	Saving	**14**	**648**	**336**	**2432**
Total Savings		41	1954	4988	8021

Note: Amount has been rounded off to nearest ₹

Above table suggested that total possible savings in depreciation and amortization component for the period of Coal India Ltd. would have been ₹ 41 crore with base year 2012-13 and 2013-14, ₹ 1954 crore of Hindalco Ltd. with 2011-12 as the base year, ₹ 4988 crore of Tata Steel Ltd. with 2010-11 as the base year and lastly ₹ 8021 crore of Vedanta Ltd. with base year 2010-11.

3. **Possible Savings in Repairs and Maintenance**

Possible savings in respect of repairs and maintenance has been detailed here as under.

Table 6.49

Possible Savings in Repairs and Maintenance of Metals Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Coal India Ltd.	Hindalco Ltd.	Tata Steel Ltd.	Vedanta Ltd.
2010-11	Standard	3	229	1053	23
	Actual	7	286	1104	23
	Saving	**4**	**57**	**51**	**0**
2011-12	Standard	4	236	1124	18
	Actual	9	236	1124	20
	Saving	**5**	**0**	**0**	**2**
2012-13	Standard	5	224	1177	6
	Actual	9	254	1260	28
	Saving	**4**	**30**	**83**	**22**
2013-14	Standard	6	222	1223	71
	Actual	6	361	1476	216
	Saving	**0**	**139**	**253**	**145**
2014-15	Standard	6	274	1188	81
	Actual	6	425	1564	298
	Saving	**0**	**151**	**376**	**217**
2015-16	Standard	7	286	1252	94
	Actual	8	444	1743	275
	Saving	**1**	**158**	**491**	**181**
2016-17	Standard	6	291	1525	110
	Actual	11	447	1936	406
	Saving	**5**	**156**	**411**	**296**
2017-18	Standard	4	332	1749	114
	Actual	19	496	2137	448
	Saving	**15**	**164**	**388**	**334**
Total Savings		34	855	2053	1196

Note: Amount has been rounded off to nearest ₹

Table 6.49 manifests that ₹ 2053 crore would be possible saving of Tata Steel Ltd. for the study period if its input is properly utilized as compared to other companies of metals sector.

4. Possible Savings in Business Service Input

Last but not the least possible savings in business service input have been calculated and would be analysed.

Table 6.50

Possible Savings in Business Service Input of Metals Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Coal India Ltd.	Hindalco Ltd.	Tata Steel Ltd.	Vedanta Ltd.
2010-11	Standard	93	979	4746	357
	Actual	283	1115	4746	2100
	Saving	**190**	**136**	**0**	**1743**
2011-12	Standard	148	1011	5066	284
	Actual	167	1011	5911	2215
	Saving	**19**	**0**	**845**	**1931**
2012-13	Standard	166	959	5302	95
	Actual	295	1230	6423	814
	Saving	**129**	**271**	**1121**	**719**
2013-14	Standard	226	949	5511	1084
	Actual	295	1135	6654	1758
	Saving	**69**	**186**	**1143**	**674**
2014-15	Standard	198	1175	5355	1250
	Actual	198	1636	6909	1373
	Saving	**0**	**461**	**1554**	**123**
2015-16	Standard	243	1224	5640	1447
	Actual	283	1821	7073	1447
	Saving	**40**	**597**	**1433**	**0**
2016-17	Standard	214	1246	6871	1687
	Actual	304	2562	13782	2868
	Saving	**90**	**1316**	**6911**	**1181**
2017-18	Standard	135	1423	7879	1760
	Actual	200	2619	10335	2938
	Saving	**65**	**1196**	**2456**	**1178**
Total Savings		603	4163	15463	7549

Note: Amount has been rounded off to nearest ₹

Table 6.50 conveys that total possible savings in business service input for a period eight years of Coal India Ltd. might have been ₹ 603 crore with base year 2014-15, ₹ 4163 crore of Hindalco Ltd. having 2011-12 as the base year, ₹ 15463 crore of Tata Steel Ltd. with base year 2010-11 and lastly ₹ 7549 crore of savings may be possible of Vedanta Ltd. with base year 2015-16.

6.5.5. Possible Savings in Overhead Input of Pharmaceutical Sector Companies

To know and for suggesting to improve the performance of pharmaceutical sector companies in respect of the overhead and its parts an attempt has been made to calculate the possible savings.

Table 6.51

Possible Savings in Overhead Input of Pharmaceutical Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Cipla Ltd.	Dr. Reddy's Laboratories Ltd.	Lupin Ltd.	Sun Pharmaceutical Industries Ltd.
2010-11	Standard	1756	1886	1080	651
	Actual	1853	1995	1228	700
	Saving	**97**	**109**	**148**	**49**
2011-12	Standard	1824	2175	1155	775
	Actual	1842	2418	1404	775
	Saving	**18**	**243**	**249**	**0**
2012-13	Standard	1947	2568	1432	450
	Actual	1982	2568	1670	612
	Saving	**35**	**0**	**238**	**162**
2013-14	Standard	2159	2795	1813	479
	Actual	2159	2976	1813	1142
	Saving	**0**	**181**	**0**	**663**
2014-15	Standard	2228	2902	1884	1359
	Actual	2530	2917	1940	3268
	Saving	**302**	**15**	**56**	**1909**
2015-16	Standard	2918	3078	2263	1317
	Actual	3139	3586	2344	3114
	Saving	**221**	**508**	**81**	**1797**
2016-17	Standard	2557	2994	2494	1322
	Actual	3394	3376	2943	2509
	Saving	**837**	**382**	**449**	**1187**
2017-18	Standard	2573	2681	1971	1456
	Actual	3111	3251	2596	2278
	Saving	**538**	**570**	**625**	**822**
Total Savings		2048	2007	1847	6589

Note: Amount has been rounded off to nearest ₹

Table 6.51 portrays the total possible savings in overhead input would have been ₹ 2048 crore of Cipla Ltd, ₹ 2007 crore of Dr. Reddy's Laboratories Ltd., ₹ 1847 crore of Lupin Ltd. and lastly ₹ 6589 crore of Sun Pharmaceutical Industries Ltd. For calculating possible savings year of the lowest overhead input output ratio has been taken as the base year. The year 2013-14 has been regarded as the base year for Cipla Ltd. and Lupin Ltd. while the year 2012-13 is regarded as the base year for Dr. Reddy's Laboratories Ltd. and 2011-12 is considered as a base year for Sun Pharmaceutical Industries Ltd.

1. Possible Savings in Power and Fuel

The significant component of overhead input is power and fuel. Its possible savings has been calculated and results have been analysed as below:

Table 6.52

Possible Savings in Power and Fuel of Pharmaceutical Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Cipla Ltd.	Dr. Reddy's Laboratories Ltd.	Lupin Ltd.	Sun Pharmaceutical Industries Ltd.
2010-11	Standard	119	133	141	39
	Actual	164	145	197	39
	Saving	**45**	**12**	**56**	**0**
2011-12	Standard	124	154	151	47
	Actual	186	156	226	60
	Saving	**62**	**2**	**75**	**13**
2012-13	Standard	132	181	187	27
	Actual	173	231	246	76
	Saving	**41**	**50**	**59**	**49**
2013-14	Standard	147	197	237	29
	Actual	147	197	237	89
	Saving	**0**	**0**	**0**	**60**
2014-15	Standard	151	205	246	82
	Actual	162	242	274	312
	Saving	**11**	**37**	**28**	**230**
2015-16	Standard	198	217	296	79
	Actual	210	282	355	376
	Saving	**12**	**65**	**59**	**297**
2016-17	Standard	174	211	326	80
	Actual	210	301	340	355
	Saving	**36**	**90**	**14**	**275**
2017-18	Standard	175	189	258	88
	Actual	225	280	359	354
	Saving	**50**	**91**	**101**	**266**
Total Savings		258	346	392	1190

Note: Amount has been rounded off to nearest ₹

Table 6.52 describes that the total possible savings in power and fuel for a period of eight years would have been as high as ₹ 1190 crore of Sun Pharmaceutical Industries Ltd., followed by ₹ 392 crore of Lupin Ltd., ₹ 346 crore of Dr. Reddy's Laboratories Ltd. and lastly ₹ 258 crore of Cipla Ltd. For calculating possible savings year of the lowest power and fuel input output ratio has been taken as the base year.

2. **Possible Savings in Depreciation and Amortisation**

Possible savings in depreciation and amortisation has been calculated as given below:

Table 6.53

Possible Savings in Depreciation and Amortisation of Pharmaceutical Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Cipla Ltd.	Dr. Reddy's Laboratories Ltd.	Lupin Ltd.	Sun Pharmaceutical Industries Ltd.
2010-11	Standard	229	230	100	64
	Actual	229	248	104	64
	Saving	**0**	**18**	**4**	**0**
2011-12	Standard	238	265	107	76
	Actual	282	301	132	76
	Saving	**44**	**36**	**25**	**0**
2012-13	Standard	254	313	132	44
	Actual	303	313	150	86
	Saving	**49**	**0**	**18**	**42**
2013-14	Standard	281	341	168	47
	Actual	324	381	168	102
	Saving	**43**	**40**	**0**	**55**
2014-15	Standard	291	354	174	133
	Actual	433	490	337	661
	Saving	**142**	**136**	**163**	**528**
2015-16	Standard	380	375	209	129
	Actual	441	649	306	464
	Saving	**61**	**274**	**97**	**335**
2016-17	Standard	333	365	230	129
	Actual	751	735	366	422
	Saving	**418**	**370**	**136**	**293**
2017-18	Standard	336	327	182	142
	Actual	530	774	390	432
	Saving	**194**	**447**	**208**	**290**
Total Savings		951	1322	652	1543

Note: Amount has been rounded off to nearest ₹

Above table 6.53 stated the total possible savings in depreciation and amortisation segment of overhead input of Cipla Ltd. might have been ₹ 951 crore. It could be ₹ 1322 crore of Dr. Reddy's Laboratories Ltd., ₹ 652 crore of Lupin Ltd. and lastly ₹ 1543 crore of savings might be possible of Sun Pharmaceutical Industries Ltd.

3. **Possible Savings in Repairs and Maintenance**

Another component of overhead input is repairs and maintenance. Its possible savings has been calculated as under:

Table 6.54

Possible Savings in Repairs and Maintenance of Pharmaceutical Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Cipla Ltd.	Dr. Reddy's Laboratories Ltd.	Lupin Ltd.	Sun Pharmaceutical Industries Ltd.
2010-11	Standard	44	87	63	34
	Actual	128	160	66	34
	Saving	**84**	**73**	**3**	**0**
2011-12	Standard	46	101	68	40
	Actual	161	164	74	47
	Saving	**115**	**63**	**6**	**7**
2012-13	Standard	49	119	84	24
	Actual	84	119	95	63
	Saving	**35**	**0**	**11**	**39**
2013-14	Standard	54	129	106	25
	Actual	66	144	106	71
	Saving	**12**	**15**	**0**	**46**
2014-15	Standard	56	134	110	71
	Actual	64	163	127	162
	Saving	**8**	**29**	**17**	**91**
2015-16	Standard	74	142	132	69
	Actual	74	198	146	168
	Saving	**0**	**56**	**14**	**99**
2016-17	Standard	64	138	146	69
	Actual	81	232	183	175
	Saving	**17**	**94**	**37**	**106**
2017-18	Standard	65	124	115	76
	Actual	81	226	191	177
	Saving	**16**	**102**	**76**	**101**
Total Savings		287	432	164	489

Note: Amount has been rounded off to nearest ₹

Table 6.54 depicts that ₹ 287 crore would be possible savings of Cipla Ltd. if its input is optimally utilized. Dr. Reddy's Laboratories Ltd. would also have saved ₹ 432 crore, Lupin Ltd. would have saved ₹ 164 crore and lastly Sun Pharmaceutical Industries Ltd. would have saved ₹ 489 crore.

4. **Possible Savings in Business Service Input**

The last component of overhead input is business service input. Its possible savings has been calculated as follows:

Table 6.55

Possible Savings in Business Service Input of Pharmaceutical Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Cipla Ltd.	Dr. Reddy's Laboratories Ltd.	Lupin Ltd.	Sun Pharmaceutical Industries Ltd.
2010-11	Standard	1168	1314	689	497
	Actual	1332	1442	861	562
	Saving	**164**	**128**	**172**	**65**
2011-12	Standard	1214	1516	737	591
	Actual	1214	1797	972	591
	Saving	**0**	**281**	**235**	**0**
2012-13	Standard	1295	1789	913	344
	Actual	1422	1905	1179	387
	Saving	**127**	**116**	**266**	**43**
2013-14	Standard	1436	1947	1156	365
	Actual	1622	2254	1302	880
	Saving	**186**	**307**	**146**	**515**
2014-15	Standard	1482	2022	1202	1037
	Actual	1871	2022	1202	2134
	Saving	**389**	**0**	**0**	**1097**
2015-16	Standard	1941	2145	1443	1006
	Actual	2413	2457	1536	2106
	Saving	**472**	**312**	**93**	**1100**
2016-17	Standard	1701	2086	1591	1009
	Actual	2352	2107	2054	1557
	Saving	**651**	**21**	**463**	**548**
2017-18	Standard	1712	1868	1257	1111
	Actual	2276	1972	1656	1315
	Saving	**564**	**104**	**399**	**204**
Total Savings		2552	1269	1774	3571

Note: Amount has been rounded off to nearest ₹

Table 6.55 depicts that ₹ 2552 crore would be possible savings of Cipla Ltd. if its input is optimally utilized. Dr. Reddy's Laboratories Ltd. would have saved ₹ 1269 crore, Lupin Ltd. would have saved ₹ 1774 crore and lastly Sun Pharmaceutical Industries Ltd. would have saved ₹ 3571 crore.

6.5.6. Possible Savings in Overhead Input of Refineries Sector Companies

For suggesting the refineries sector companies in respect of the overhead an effort has been taken to calculate the possible savings in overhead along with its all the four components viz., power and fuel, depreciation and amortisation, repairs and maintenance and business service input.

Table 6.56

Possible Savings in Overhead Input of Refineries Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bharat Petroleum Corporation Ltd.	Hindustan Petroleum Corporation Ltd.	Indian Oil Corporation Ltd.	Reliance Industries Ltd.
2010-11	Standard	7154	6439	18436	19442
	Actual	8012	7035	18436	26195
	Saving	**858**	**596**	**0**	**6753**
2011-12	Standard	9252	8039	22555	24126
	Actual	9668	8039	22664	24594
	Saving	**416**	**0**	**109**	**468**
2012-13	Standard	9773	8782	21616	24580
	Actual	9773	8870	23769	25538
	Saving	**0**	**88**	**2153**	**958**
2013-14	Standard	10016	8943	21921	25550
	Actual	10984	9619	27586	25550
	Saving	**968**	**676**	**5665**	**0**
2014-15	Standard	9333	8376	20487	21468
	Actual	11742	9573	26533	27952
	Saving	**2409**	**1197**	**6046**	**6484**
2015-16	Standard	7603	7419	16857	16071
	Actual	12701	12898	32127	30384
	Saving	**5098**	**5479**	**15270**	**14313**
2016-17	Standard	7756	7424	16223	15866
	Actual	11537	10618	34148	30785
	Saving	**3781**	**3194**	**17925**	**14919**
2017-18	Standard	9057	8691	19402	18481
	Actual	13910	11681	31045	32376
	Saving	**4853**	**2990**	**11643**	**13895**
Total Savings		18384	14221	58811	57790

Note: Amount has been rounded off to nearest ₹

Table 6.56 exhibits that the total possible savings in overhead input for a period of eight years would have been ₹ 18384 crore of Bharat Petroleum Corporation Ltd., ₹ 14221 crore of Hindustan Petroleum Corporation Ltd., ₹ 58811 crore of Indian Oil Corporation Ltd. and lastly ₹ 57790 crore of Reliance Industries Ltd. For calculating possible savings year of the lowest overhead input output ratio has been taken as the base year.

1. Possible Savings in Power and Fuel

The possible savings in power and fuel segment of overhead input has been calculated as below:

Table 6.57

Possible Savings in Power and Fuel of Refineries Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bharat Petroleum Corporation Ltd.	Hindustan Petroleum Corporation Ltd.	Indian Oil Corporation Ltd.	Reliance Industries Ltd.
2010-11	Standard	476	66	1880	2255
	Actual	476	340	1880	2255
	Saving	**0**	**274**	**0**	**0**
2011-12	Standard	606	82	2315	2800
	Actual	629	456	3338	3595
	Saving	**23**	**374**	**1023**	**795**
2012-13	Standard	640	90	2219	2853
	Actual	741	520	4363	5869
	Saving	**101**	**430**	**2144**	**3016**
2013-14	Standard	656	84	2250	2966
	Actual	916	84	4754	7767
	Saving	**260**	**0**	**2504**	**4801**
2014-15	Standard	612	85	2103	2492
	Actual	1415	138	4991	10024
	Saving	**803**	**53**	**2888**	**7532**
2015-16	Standard	498	76	1730	1865
	Actual	1584	233	4672	9874
	Saving	**1086**	**157**	**2942**	**8009**
2016-17	Standard	508	76	1665	1842
	Actual	1332	139	3988	10323
	Saving	**824**	**63**	**2323**	**8481**
2017-18	Standard	594	89	1992	2145
	Actual	1646	333	4495	12765
	Saving	**1052**	**244**	**2503**	**10620**
Total Savings		4148	1596	16326	43253

Note: Amount has been rounded off to nearest ₹

Above table 6.57 highlighted that ₹ 4148 crore of Bharat Petroleum Corporation Ltd., ₹ 1596 crore of Hindustan Petroleum Corporation Ltd., ₹ 16326 crore of Indian Oil Corporation Ltd. and lastly ₹ 43253 crore of Reliance Industries Ltd. would have been as possible savings in power and fuel of refineries sector companies.

2. Possible Savings in Depreciation and Amortisation

The next important part of overhead input to discuss and analyse is depreciation and amortisation which has been calculated as under:

Table 6.58

Possible Savings in Depreciation and Amortisation of Refineries Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bharat Petroleum Corporation Ltd.	Hindustan Petroleum Corporation Ltd.	Indian Oil Corporation Ltd.	Reliance Industries Ltd.
2010-11	Standard	1407	1380	3984	6695
	Actual	1655	1407	4547	13608
	Saving	**248**	**27**	**563**	**6913**
2011-12	Standard	1819	1713	4868	8309
	Actual	1885	1713	4868	11394
	Saving	**66**	**0**	**0**	**3085**
2012-13	Standard	1926	1882	4668	8465
	Actual	1926	1984	5201	9465
	Saving	**0**	**102**	**533**	**1000**
2013-14	Standard	1969	1916	4733	8789
	Actual	2247	2202	5760	8789
	Saving	**278**	**286**	**1027**	**0**
2014-15	Standard	1835	1795	4424	7393
	Actual	2516	1979	4529	8488
	Saving	**681**	**184**	**105**	**1095**
2015-16	Standard	1495	1590	3640	5535
	Actual	1854	2659	4853	9566
	Saving	**359**	**1069**	**1213**	**4031**
2016-17	Standard	1525	1591	3503	5464
	Actual	1891	2535	6223	8465
	Saving	**366**	**944**	**2720**	**3001**
2017-18	Standard	1781	1862	4189	6365
	Actual	2648	2753	7067	9580
	Saving	**867**	**891**	**2878**	**3215**
Total Savings		2866	3503	9039	22340

Note: Amount has been rounded off to nearest ₹

Above table reveals that the total possible savings in depreciation and amortisation element of overhead input for a period of eight years of Bharat Petroleum Corporation Ltd. might have been ₹ 2866 crore. It might be ₹ 3503 crore of Hindustan Petroleum Corporation Ltd., ₹ 9039 crore of Indian Oil Corporation Ltd. and lastly ₹ 22340 crore of savings may be possible of Reliance Industries Ltd.

3. **Possible Savings in Repairs and Maintenance**

Repairs and maintenance related possible savings has been stated below:

Table 6.59

Possible Savings in Repairs and Maintenance of Refineries Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bharat Petroleum Corporation Ltd.	Hindustan Petroleum Corporation Ltd.	Indian Oil Corporation Ltd.	Reliance Industries Ltd.
2010-11	Standard	454	499	1274	645
	Actual	538	649	1469	904
	Saving	**84**	**150**	**195**	**259**
2011-12	Standard	585	629	1575	800
	Actual	585	629	1575	942
	Saving	**0**	**0**	**0**	**142**
2012-13	Standard	619	681	1492	820
	Actual	679	698	1738	820
	Saving	**60**	**17**	**246**	**0**
2013-14	Standard	635	694	1513	854
	Actual	823	719	2040	854
	Saving	**188**	**25**	**527**	**0**
2014-15	Standard	592	650	1414	712
	Actual	710	840	2248	1015
	Saving	**118**	**190**	**834**	**303**
2015-16	Standard	482	575	1164	533
	Actual	763	941	2632	1161
	Saving	**281**	**366**	**1468**	**628**
2016-17	Standard	492	576	1120	526
	Actual	786	996	2468	1200
	Saving	**294**	**420**	**1348**	**674**
2017-18	Standard	574	674	1339	613
	Actual	875	1089	2912	1334
	Saving	**301**	**415**	**1573**	**721**
Total Savings		1325	1583	6191	2727

Note: Amount has been rounded off to nearest ₹

Table 6.59 conveys that ₹ 1325 crore would be possible savings of Bharat Petroleum Corporation Ltd. if its input is optimally utilized. Hindustan Petroleum Corporation Ltd. would have saved ₹ 1583 crore, Indian Oil Corporation Ltd. would have saved ₹ 6191 crore and lastly Reliance Industries Ltd. would have saved ₹ 2727 crore.

4. **Possible Savings in Business Service Input**

Another vital part of overhead input is Business Service Input. Its possible savings has been calculated and results have been analysed as stated below:

Table 6.60

Possible Savings in Business Service Input of Refineries Sector Companies from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bharat Petroleum Corporation Ltd.	Hindustan Petroleum Corporation Ltd.	Indian Oil Corporation Ltd.	Reliance Industries Ltd.
2010-11	Standard	4704	4152	10541	6199
	Actual	5343	4640	10541	9428
	Saving	**639**	**488**	**0**	**3229**
2011-12	Standard	6083	5179	12884	7693
	Actual	6570	5241	12884	8664
	Saving	**487**	**62**	**0**	**971**
2012-13	Standard	6427	5668	12358	7838
	Actual	6427	5668	12467	9384
	Saving	**0**	**0**	**109**	**1546**
2013-14	Standard	6585	5767	12532	8140
	Actual	6998	6615	15032	8140
	Saving	**413**	**848**	**2500**	**0**
2014-15	Standard	6136	5402	11712	6846
	Actual	7101	6617	14766	8425
	Saving	**965**	**1215**	**3054**	**1579**
2015-16	Standard	4999	4784	9637	5125
	Actual	8500	9064	19969	9783
	Saving	**3501**	**4280**	**10332**	**4658**
2016-17	Standard	5099	4787	9274	5059
	Actual	7528	6948	21469	10798
	Saving	**2429**	**2161**	**12195**	**5739**
2017-18	Standard	5955	5605	11092	5893
	Actual	8740	7506	16571	8698
	Saving	**2785**	**1901**	**5479**	**2805**
Total Savings		11218	10954	33669	20526

Note: Amount has been rounded off to nearest ₹

Table 6.60 suggests that the highest savings would be possible of Indian Oil Corporation Ltd. with ₹ 33669 crore and the lowest savings amounts to ₹ 10954 crore of Hindustan Petroleum Corporation Ltd.

6.6. Comparative Analysis of Average Overhead Productivity Ratios

To analyse between the companies of a particular sector it is better to analyse its average performance for the study period. In the present section of study an attempt has been made to analyse and interpret the results on the basis of average performance.

Table 6.61

Comparative Analysis of Average Overhead Productivity Ratios of Automobile Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Power and Fuel (Input Output Ratio)		Depreciation and Amortisation (Input Output Ratio)		Repairs and Maintenance (Input Output Ratio)		Business Service Input (Input Output Ratio)		Total Overhead (Input Output Ratio)		Overhead Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
Bajaj Auto Ltd.	0.0052	1	0.0121	1	0.0069	3	0.0395	1	0.0637	1	16.4343	1	5.165	2
Mahindra & Mahindra Ltd.	0.0057	2	0.0280	2	0.0073	4	0.0824	2	0.1234	2	8.2461	2	2.336	1
Maruti Suzuki India Ltd.	0.0103	3	0.0467	3	0.0036	2	0.1074	3	0.1680	3	6.0485	3	7.403	3
Tata Motors Ltd.	0.0106	4	0.0588	4	0.0027	1	0.1342	4	0.2063	4	5.0441	4	12.016	4

Power and Fuel Average Input Output Ratio: The power and fuel average input output ratio is the best of Bajaj Auto Ltd. by 0.0052, followed by 0.0057 of Mahindra & Mahindra Ltd. then followed by 0.0103 of Maruti Suzuki India Ltd. and lastly 0.0106 of Tata Motors Ltd.

Depreciation and Amortisation Average Input Output Ratio: It is the best of Bajaj Auto Ltd. as compared to Mahindra & Mahindra Ltd., Maruti Suzuki India Ltd. and Tata Motors Ltd.

Repairs and Maintenance Average Input Output Ratio: It is 0.0027 of Tata Motors Ltd. 0.0036 of Maruti Suzuki India Ltd., 0.0069 of Bajaj Auto Ltd. and lastly 0.0073 of Mahindra & Mahindra Ltd.

Business Service Input Average Input Output Ratio: It is the best of Bajaj Auto Ltd., followed by Mahindra & Mahindra Ltd., Maruti Suzuki India Ltd. and Tata Motors Ltd.

Total Overhead Average Input Output Ratio: The total overhead average input output ratio is the best of Bajaj Auto Ltd. with 0.0637, Mahindra & Mahindra Ltd. with 0.1234, Maruti Suzuki India Ltd. with 0.1680 and lastly Tata Motors Ltd. with 0.2063.

Average Overhead Productivity Ratio: Average overhead productivity ratio is the best of Bajaj Auto Ltd. with 16.4343 which means that for one ₹ of overhead input, the output produced is approximately ₹ 16. This is followed by Mahindra & Mahindra Ltd. with 8.2461, then Maruti Suzuki India Ltd. with 6.0485 and lastly Tata Motors Ltd. with 5.0441.

Chi-square Test: On analysing the chi-square of the automobile sector companies included in Nifty 50 it has been observed that Mahindra & Mahindra Ltd. has the least chi-square value with 2.336 then the Bajaj Auto Ltd. with 5.165 followed by Maruti Suzuki India Ltd. with 7.403 and lastly it is Tata Motors Ltd. with the highest chi-square value 12.016. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square is accepted in all the above cases. This means that the alternative hypothesis is rejected. This reveals that the overhead productivity ratios of all the companies of automobile sector of Nifty 50 for the eight years period are approximately the same.

Table 6.62

Comparative Analysis of Average Overhead Productivity Ratios of Energy Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Power and Fuel (Input Output Ratio)		Depreciation and Amortisation (Input Output Ratio)		Repairs and Maintenance (Input Output Ratio)		Business Service Input (Input Output Ratio)		Total Overhead (Input Output Ratio)		Overhead Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
GAIL (India) Ltd.	0.0351	4	0.0259	1	0.0073	1	0.0376	2	0.1059	1	9.5189	1	1.754	3
NTPC Ltd.	0.0102	3	0.0727	2	0.0299	4	0.0299	1	0.1428	2	7.2808	2	6.982	4
Oil and Natural Gas Corporation Ltd.	0.0052	1	0.2542	3	0.0122	2	0.2612	4	0.5328	4	1.8855	4	1.718	2
Power Grid Corporation of India Ltd.	0.0086	2	0.3160	4	0.0211	3	0.0425	3	0.3881	3	2.6115	3	1.096	1

Power and Fuel Average Input Output Ratio: The power and fuel average input output ratio is the best of Oil and Natural Gas Corporation Ltd. by 0.0052, followed by 0.0086 of Power Grid Corporation of India Ltd., 0.0102 of NTPC Ltd. and lastly 0.0351 of GAIL (India) Ltd.

Depreciation and Amortisation Average Input Output Ratio: It is the best of GAIL (India) Ltd. as compared to other companies of energy sector.

Repairs and Maintenance Average Input Output Ratio: It is 0.0073 of GAIL (India) Ltd., 0.0122 of Oil and Natural Gas Corporation Ltd., 0.0211 of Power Grid Corporation of India Ltd. and lastly 0.0299 of NTPC Ltd.

Business Service Input Average Input Output Ratio: It is best of NTPC Ltd., followed by GAIL (India) Ltd., Power Grid Corporation of India Ltd. and Oil and Natural Gas Corporation Ltd.

Total Overhead Average Input Output Ratio: The total overhead average input output ratio is the best of GAIL (India) Ltd. with 0.1059 followed by NTPC Ltd.,

Power Grid Corporation of India Ltd. and lastly Oil and Natural Gas Corporation Ltd. with 0.5328.

Average Overhead Productivity Ratio: Average overhead productivity ratio is the best of GAIL (India) Ltd. with 9.5189 which means that for one ₹ of overhead input, the output produced is approximately ₹ 10. This is followed by NTPC Ltd. with 7.2808, then Power Grid Corporation of India Ltd. with 2.6115 and lastly Oil and Natural Gas Corporation Ltd. with 1.8855.

Chi-square Test: On analysing the chi-square of the energy sector companies included in Nifty 50 it has been observed that Power Grid Corporation of India Ltd. has the least chi-square value with 1.096 then the Oil and Natural Gas Corporation Ltd., followed by GAIL (India) Ltd. and lastly it is NTPC Ltd. with the highest chi-square value 6.982. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square is accepted in all the above cases.

Table 6.63

Comparative Analysis of Average Overhead Productivity Ratios of Information Technology Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Power and Fuel (Input Output Ratio)		Depreciation and Amortisation (Input Output Ratio)		Repairs and Maintenance (Input Output Ratio)		Business Service Input (Input Output Ratio)		Total Overhead (Input Output Ratio)		Overhead Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
Infosys Ltd.	0.0040	1	0.0262	3	0.0114	4	0.1341	1	0.1756	1	5.7175	1	2.393	2
Tata Consultancy Services Ltd.	0.0052	3	0.0196	1	0.0045	1	0.2757	3	0.3050	3	3.5628	3	41.852	4
Tech Mahindra Ltd.	0.0079	4	0.0306	4	0.0096	3	0.4100	4	0.4581	4	2.2024	4	3.948	3
Wipro Ltd.	0.0048	2	0.0237	2	0.0051	2	0.2240	2	0.2577	2	3.8989	2	1.011	1

Power and Fuel Average Input Output Ratio: The power and fuel average input output ratio is the best of Infosys Ltd. by 0.0040, followed by 0.0048 of Wipro Ltd., then followed by 0.0052 of Tata Consultancy Services Ltd. and lastly 0.0079 of Tech Mahindra Ltd.

Depreciation and Amortisation Average Input Output Ratio: It is the best of Tata Consultancy Services Ltd. as compared to others.

Repairs and Maintenance Average Input Output Ratio: It is 0.0114 of Infosys Ltd., 0.0045 of Tata Consultancy Services Ltd., 0.0096 of Tech Mahindra Ltd. and lastly 0.0051 of Wipro Ltd.

Business Service Input Average Input Output Ratio: It is the best of Infosys Ltd. as compared to Wipro Ltd., Tata Consultancy Services Ltd. and Tech Mahindra Ltd.

Total Overhead Average Input Output Ratio: The total overhead average input output ratio is the best of Infosys Ltd. with 0.1756, Wipro Ltd. with 0.2577, Tata Consultancy Services Ltd. with 0.3050 and lastly Tech Mahindra Ltd. with 0.4581.

Average Overhead Productivity Ratio: Average overhead productivity ratio is the best of Infosys Ltd. with 5.7175. This is followed by Wipro Ltd. with 3.8989, then Tata Consultancy Services Ltd. with 3.5628 and lastly Tech Mahindra Ltd. with 2.2024.

Chi-square Test: On analysing the chi-square of the information technology sector companies it has been observed that Wipro Ltd. has the least chi-square value and Tata Consultancy Services Ltd. has the highest chi-square value. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis is accepted in all the above cases except Tata Consultancy Services Ltd.

Table 6.64

Comparative Analysis of Average Overhead Productivity Ratios of Metals Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Power and Fuel (Input Output Ratio)		Depreciation and Amortisation (Input Output Ratio)		Repairs and Maintenance (Input Output Ratio)		Business Service Input (Input Output Ratio)		Total Overhead (Input Output Ratio)		Overhead Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
Coal India Ltd.	0.0008	1	0.0010	1	0.0010	1	0.0261	1	0.0289	1	38.3249	1	121.065	4
Hindalco Ltd.	0.1440	4	0.0361	2	0.0134	3	0.0585	2	0.2520	2	4.2212	2	5.222	2
Tata Steel Ltd.	0.0515	2	0.0699	4	0.0421	4	0.2083	4	0.3718	4	2.7600	4	4.808	1
Vedanta Ltd.	0.1140	3	0.0474	3	0.0086	2	0.1634	3	0.3334	3	3.3428	3	48.543	3

Power and Fuel Average Input Output Ratio: The power and fuel average input output ratio is the best of Coal India Ltd. by 0.0008, followed by 0.0515 of Tata Steel Ltd. then followed by 0.1140 of Vedanta Ltd. and lastly 0.1440 of Hindalco Ltd.

Depreciation and Amortisation Average Input Output Ratio: It is the best of Coal India Ltd. as compared to Hindalco Ltd., Vedanta Ltd. and Tata Steel Ltd.

Repairs and Maintenance Average Input Output Ratio: It is 0.0010 of Coal India Ltd., 0.0086 of Vedanta Ltd., 0.0134 of Hindalco Ltd. and lastly 0.0421 of Tata Steel Ltd.

Business Service Input Average Input Output Ratio: It is best of Coal India Ltd. as compared to the other companies of the metals sector.

Total Overhead Average Input Output Ratio: The total overhead average input output ratio is the best of Coal India Ltd. with 0.0289, Hindalco Ltd. with 0.2520, Vedanta Ltd. with 0.3334 and lastly Tata Steel Ltd. with 0.3718.

Average Overhead Productivity Ratio: Average overhead productivity ratio is the best of Coal India Ltd. with 38.3249 which means that for one ₹ of overhead input, the output produced is approximately ₹ 38. This is followed by Hindalco Ltd. with 4.2212, then Vedanta Ltd. with 3.3428 and lastly Tata Steel Ltd. with 2.7600.

Chi-square Test: On analysing the chi-square of the metals sector companies included in Nifty 50 it has been observed that Tata Steel Ltd. has the least chi-square value with 4.808 then the Hindalco Ltd. with 5.222 followed by Vedanta Ltd. with 48.543 and lastly it is Coal India Ltd. with the highest chi-square value 121.065. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis is accepted in case of Tata Steel Ltd. and Hindalco Ltd. while it is rejected in case of Vedanta Ltd. and Coal India Ltd.

Table 6.65

Comparative Analysis of Average Overhead Productivity Ratios of Pharmaceutical Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Power and Fuel (Input Output Ratio)		Depreciation and Amortisation (Input Output Ratio)		Repairs and Maintenance (Input Output Ratio)		Business Service Input (Input Output Ratio)		Total Overhead (Input Output Ratio)		Overhead Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
Cipla Ltd.	0.0232	1	0.0500	2	0.0122	1	0.2219	2	0.3073	2	3.2826	2	2.586	2
Dr. Reddy's Laboratories Ltd.	0.0304	2	0.0636	4	0.0238	4	0.2678	4	0.3856	4	2.6038	4	2.029	1
Lupin Ltd.	0.0389	4	0.0319	1	0.0166	2	0.1844	1	0.2718	1	3.7084	1	6.155	3
Sun Pharmaceutical Industries Ltd.	0.0375	3	0.0507	3	0.0222	3	0.2362	3	0.3465	3	3.2248	3	39.108	4

Power and Fuel Average Input Output Ratio: The power and fuel average input output ratio is the best of Cipla Ltd. by 0.0232, followed by 0.0304 of Dr.

Reddy's Laboratories Ltd., 0.0375 of Sun Pharmaceutical Industries Ltd. and lastly 0.0389 of Lupin Ltd.

Depreciation and Amortisation Average Input Output Ratio: It is the best of Lupin Ltd. as compared to other companies of pharmaceutical sector.

Repairs and Maintenance Average Input Output Ratio: It is 0.0122 of Cipla Ltd. 0.0166 of Lupin Ltd., 0.0222 of Sun Pharmaceutical Industries Ltd. and lastly 0.0238 of Dr. Reddy's Laboratories Ltd.

Business Service Input Average Input Output Ratio: It is the best of Lupin Ltd., followed by Cipla Ltd., Sun Pharmaceutical Industries Ltd. and Dr. Reddy's Laboratories Ltd.

Total Overhead Average Input Output Ratio: The total overhead average input output ratio is the best of Lupin Ltd. with 0.2718 as compared to others.

Average Overhead Productivity Ratio: Average overhead productivity ratio is the best of Lupin Ltd. with 3.7084 which means that for every ₹ of overhead input, the output produced is approximately ₹ 4. This is followed by Cipla Ltd. with 3.2826, then Sun Pharmaceutical Industries Ltd. with 3.2248 and lastly Dr. Reddy's Laboratories Ltd. with 2.6038.

Chi-square Test: On analysing the chi-square of the pharmaceutical sector Companies included in Nifty 50 it has been observed that Dr. Reddy's Laboratories Ltd. has the least chi-square value with 2.029 then the Cipla Ltd., followed by Lupin Ltd. and lastly it is Sun Pharmaceutical Industries Ltd. with the highest chi-square value 39.108. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square is accepted in all the cases except in Sun Pharmaceutical Industries Ltd.

Table 6.66

Comparative Analysis of Average Overhead Productivity Ratios of Refineries Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Power and Fuel (Input Output Ratio)		Depreciation and Amortisation (Input Output Ratio)		Repairs and Maintenance (Input Output Ratio)		Business Service Input (Input Output Ratio)		Total Overhead (Input Output Ratio)		Overhead Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
Bharat Petroleum Corporation Ltd.	0.0060	2	0.0113	1	0.0039	1	0.0392	2	0.0604	2	17.1182	2	6.302	1
Hindustan Petroleum Corporation Ltd.	0.0017	1	0.0132	2	0.0051	3	0.0402	3	0.0602	1	17.1615	1	9.032	3
Indian Oil Corporation Ltd.	0.0118	3	0.0157	3	0.0063	4	0.0458	4	0.0796	3	13.4887	3	8.072	2
Reliance Industries Ltd.	0.0317	4	0.0386	4	0.0041	2	0.0362	1	0.1106	4	9.6764	4	23.860	4

Power and Fuel Average Input Output Ratio: The power and fuel average input output ratio is the best of Hindustan Petroleum Corporation Ltd. by 0.0017, followed by 0.0060 of Bharat Petroleum Corporation Ltd., then followed by 0.0118 of Indian Oil Corporation Ltd. and lastly 0.0317 of Reliance Industries Ltd.

Depreciation and Amortisation Average Input Output Ratio: It is the best of Bharat Petroleum Corporation Ltd. as compared to Hindustan Petroleum Corporation Ltd., Indian Oil Corporation Ltd. and Reliance Industries Ltd.

Repairs and Maintenance Average Input Output Ratio: It is 0.0039 of Bharat Petroleum Corporation Ltd., 0.0051 of Hindustan Petroleum Corporation Ltd., 0.0063 of Indian Oil Corporation Ltd. and lastly 0.0041 of Reliance Industries Ltd.

Business Service Input Average Input Output Ratio: It is the best of Reliance Industries Ltd. as compared to others.

Total Overhead Average Input Output Ratio: The total overhead average input output ratio is the best of Hindustan Petroleum Corporation Ltd. with 0.0602, Bharat Petroleum Corporation Ltd. with 0.0604, Indian Oil Corporation Ltd. with 0.0796 and lastly Reliance Industries Ltd. with 0.1106.

Average Overhead Productivity Ratio: Average overhead productivity ratio is the best of Hindustan Petroleum Corporation Ltd. with 17.1615. This is followed by Bharat Petroleum Corporation Ltd. with 17.1182, then Indian Oil Corporation Ltd. with 13.4887 and lastly Reliance Industries Ltd. with 9.6764.

Chi-square Test: On analysing the chi-square of the refineries sector companies it has been observed that Bharat Petroleum Corporation Ltd. has the least chi-

square value with 6.302 and Reliance Industries Ltd. with the highest chi-square value 23.860. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square is accepted in all the above cases except Reliance Industries Ltd.

6.7. Concluding Observations

After understanding the productivity of material, labour and its components, now it's time to understand the concept of overhead productivity. This chapter deals with the overhead productivity computed with the help of overhead input. Overhead are the expenses which are not related to any specific job, product or process but hold a major position of expenses. Here for the purpose of study, overheads are broadly divided into 4 heads, viz., power and fuel, depreciation and amortisation, repairs and maintenance and business service input. Two hypotheses have been drawn and which has been tested through the non-parametric test namely, chi-square test and kruskal wallis one way analysis of variance test. On analysing the average overhead productivity, Bajaj Auto Ltd. has the highest productivity in automobile sector, GAIL (India) Ltd. has the maximum overhead productivity as compared to other companies in energy sector, Infosys Ltd. is the best in information technology sector, Coal India Ltd. is the best in metals sector, Lupin Ltd. in pharmaceutical and lastly Hindustan Petroleum Corporation Ltd. in refineries sector.

Next chapter highlights the overall productivity performance of the companies of different sectors.

Appendices

Appendix 6.1 to 6.4. Revaluation of Overhead Input of Automobile Sector Companies

Appendix 6.1

Revaluation of Overhead Input of Bajaj Auto Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	86.61	101.85	89.42	121.33	99.37	106.16	81.21	114.70	93.48	120.66	122.35	96.46	98.10	100.26	94.34
2	Depreciation and Amortisation	122.84	145.62	145.62	166.77	166.77	179.61	179.61	267.40	267.40	307.16	307.16	307.29	307.29	314.80	314.80
3	Repairs and Maintenance	79.67	102.69	94.27	130.64	112.22	144.67	118.05	199.73	160.98	203.01	169.92	188.06	154.77	163.26	130.44
4	Business Service Input	474.55	578.25	530.83	681.92	585.77	796.06	649.58	989.44	797.49	1167.89	977.52	1079.11	888.11	1251.90	1000.27
	Total Overhead Input	763.67	928.41	860.15	1100.66	964.13	1226.50	1028.46	1571.27	1319.35	1798.72	1576.95	1670.92	1448.27	1830.22	1539.86

Appendix 6.2

Revaluation of Overhead Input of Mahindra & Mahindra Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	143.93	175.78	154.33	206.39	169.03	221.35	169.33	222.41	181.26	230.64	233.87	230.33	234.25	247.13	232.55
2	Depreciation and Amortisation	413.86	576.14	576.14	710.81	710.81	863.34	863.34	974.90	974.90	1108.61	1108.61	1526.38	1526.38	1479.42	1479.42
3	Repairs and Maintenance	161.66	215.71	198.02	244.75	210.24	286.63	233.89	305.56	246.28	358.34	299.93	350.84	288.74	389.15	310.93
4	Business Service Input	1866.17	2327.92	2137.03	2817.03	2419.83	3500.82	2856.67	3291.23	2652.73	3663.97	3066.74	4000.80	3292.66	4669.72	3731.11
	Total Overhead Input	2585.62	3295.55	3065.53	3978.98	3509.91	4872.14	4123.23	4794.10	4055.18	5361.56	4709.15	6108.35	5342.03	6785.42	5754.01

Appendix 6.3

Revaluation of Overhead Input of Maruti Suzuki India Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	210.20	229.50	201.50	493.70	404.34	594.10	454.49	712.30	580.52	692.60	702.30	517.20	525.99	671.90	632.26
2	Depreciation and Amortisation	1013.50	1138.40	1138.40	1861.20	1861.20	2084.40	2084.40	2470.30	2470.30	2823.90	2823.90	2602.10	2602.10	2757.90	2757.90
3	Repairs and Maintenance	84.80	90.40	82.99	149.10	128.08	181.90	148.43	193.10	155.64	273.10	228.58	261.90	215.54	324.70	259.44
4	Business Service Input	3547.20	3711.00	3406.70	4900.50	4209.53	4947.10	4036.83	5488.50	4423.73	6759.20	5657.45	7617.30	6269.04	8659.60	6919.02
	Total Overhead Input	4855.70	5169.30	4829.59	7404.50	6603.15	7807.50	6724.15	8864.20	7630.19	10548.80	9412.23	10998.50	9612.67	12414.10	10568.61

Appendix 6.4

Revaluation of Overhead Input of Tata Motors Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	471.28	550.89	483.68	484.66	396.94	392.09	299.95	395.88	322.64	402.36	407.99	483.48	491.70	545.12	512.96
2	Depreciation and Amortisation	1360.77	1606.74	1606.74	1817.62	1817.62	2070.30	2070.30	2603.22	2603.22	2453.75	2453.75	3037.12	3037.12	3101.89	3101.89
3	Repairs and Maintenance	128.25	175.58	161.18	187.58	161.13	143.32	116.95	166.81	134.45	157.50	131.83	0.00	0.00	0.00	0.00
4	Business Service Input	4836.92	6253.14	5740.38	5927.37	5091.61	5373.85	4385.06	6395.95	5155.14	6401.44	5358.01	6711.69	5523.72	7669.70	6128.09
	Total Overhead Input	6797.22	8586.35	7991.99	8417.23	7467.30	7979.56	6872.26	9561.86	8215.45	9415.05	8351.58	10232.29	9052.54	11316.71	9742.94

Appendix 6.5 to 6.8. Revaluation of Overhead Input of Energy Sector Companies

Appendix 6.5

Revaluation of Overhead Input of GAIL (India) Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	972.85	1065.68	935.67	1243.10	1018.10	1676.35	1282.41	1937.13	1578.76	2031.51	2059.95	1908.42	1940.86	2137.79	2011.66
2	Depreciation and Amortisation	650.25	790.71	790.71	980.94	980.94	1176.15	1176.15	974.26	974.26	1313.09	1313.09	1396.78	1396.78	1415.14	1415.14
3	Repairs and Maintenance	206.70	250.28	229.76	296.94	255.07	347.45	283.52	491.50	396.15	489.48	409.69	437.28	359.88	381.89	305.13
4	Business Service Input	1241.70	1954.26	1794.01	2122.05	1822.84	2138.66	1745.15	2849.63	2296.80	1626.26	1361.18	1399.56	1151.84	1399.16	1117.93
	Total Overhead Input	3071.50	4060.93	3750.14	4643.03	4076.95	5338.61	4487.22	6252.52	5245.97	5460.34	5143.92	5142.04	4849.36	5333.98	4849.86

Appendix 6.6

Revaluation of Overhead Input of NTPC Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	422.59	536.19	470.77	643.09	526.69	680.58	520.64	655.67	534.37	715.18	725.19	764.50	777.50	1149.78	1081.94
2	Depreciation and Amortisation	2485.69	2791.70	2791.70	3396.76	3396.76	4142.19	4142.19	4911.65	4911.65	5425.32	5425.32	5920.82	5920.82	7098.86	7098.86
3	Repairs and Maintenance	1495.48	1768.91	1623.86	1953.36	1677.94	2167.38	1768.58	2361.17	1903.10	2571.53	2152.37	2309.71	1900.89	2754.97	2201.22
4	Business Service Input	2976.88	1238.45	1136.90	1568.42	1347.27	1648.29	1345.00	1846.1	1487.96	2446.79	2047.96	1960.69	1613.65	3443.37	2751.25
	Total Overhead Input	7380.64	6335.25	6023.23	7561.63	6948.66	8638.44	7776.42	9774.59	8837.08	11158.82	10350.85	10955.72	10212.86	14446.98	13133.28

Appendix 6.7

Revaluation of Overhead Input of Oil and Natural Gas Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	285.60	316.18	277.61	334.96	274.33	380.77	291.29	390.12	317.95	511.87	519.04	558.60	568.10	500.40	470.88
2	Depreciation and Amortisation	15925.65	16829.35	16829.35	18416.67	18416.67	18761.57	18761.57	21980.77	21980.77	17287.19	17287.19	17243.99	17243.99	21501.98	21501.98
3	Repairs and Maintenance	886.78	700.13	642.72	885.65	760.77	887.40	724.12	1045.94	843.03	1465.56	1226.67	1279.13	1052.72	1164.18	930.18
4	Business Service Input	17464.04	20439.42	18763.39	23673.37	20335.42	22754.46	18567.64	24459.24	19714.15	24725.38	20695.14	22554.29	18562.18	22386.24	17886.61
	Total Overhead Input	34562.07	38285.08	36513.06	43310.65	39787.20	42784.20	38344.62	47876.07	42855.89	43990.00	39728.04	41636.01	37426.99	45552.80	40789.64

Appendix 6.8

Revaluation of Overhead Input of Power Grid Corporation of India Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	72.21	80.72	70.87	105.94	86.76	122.17	93.46	169.98	138.53	160.53	162.78	227.87	231.74	243.78	229.40
2	Depreciation and Amortisation	2199.39	2572.54	2572.54	3351.92	3351.92	3995.68	3995.68	5085.41	5085.41	6182.76	6182.76	7662.80	7662.80	9091.25	9091.25
3	Repairs and Maintenance	188.35	216.48	198.73	254.92	218.98	328.07	267.71	422.04	340.16	476.71	399.01	570.64	469.64	620.65	495.90
4	Business Service Input	438.34	512.73	470.69	510.59	438.60	662.56	540.65	762.12	614.27	899.04	752.50	930.68	765.95	1335.80	1067.30
	Total Overhead Input	2898.29	3382.47	3312.83	4223.37	4096.26	5108.48	4897.49	6439.55	6178.38	7719.04	7497.04	9391.99	9130.13	11291.48	10883.85

Appendix 6.9 to 6.12 Revaluation of Overhead Input of Information Technology Sector Companies

Appendix 6.9

Revaluation of Overhead Input of Infosys Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	142.00	154.00	135.21	180.00	147.42	181.00	138.47	185.00	150.78	179.00	181.51	180.00	183.06	162.00	152.44
2	Depreciation and Amortisation	740.00	794.00	794.00	956.00	956.00	1101.00	1101.00	913.00	913.00	1115.00	1115.00	1331.00	1331.00	1408.00	1408.00
3	Repairs and Maintenance	265.00	310.00	284.58	340.00	292.06	396.00	323.14	530.00	427.18	753.00	630.26	1073.00	883.08	902.00	720.70
4	Business Service Input	3623.00	4607.00	4229.23	4542.00	3901.58	5946.00	4851.94	6490.00	5230.94	8005.00	6700.19	8619.00	7093.44	9816.00	7842.98
	Total Overhead Input	4770.00	5865.00	5443.02	6018.00	5297.06	7624.00	6414.54	8118.00	6721.90	10052.00	8626.95	11203.00	9490.58	12288.00	10124.12

Appendix 6.10

Revaluation of Overhead Input of Tata Consultancy Services Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	240.00	292.10	256.46	375.61	307.62	463.25	354.39	493.36	402.09	510.83	517.98	0.00	0.00	0.00	0.00
2	Depreciation and Amortisation	537.82	688.17	688.17	802.86	802.86	1080.55	1080.55	1393.77	1393.77	1559.19	1559.19	1575.00	1575.00	1647.00	1647.00
3	Repairs and Maintenance	180.47	219.67	201.66	271.93	233.59	404.36	329.96	491.18	395.89	633.03	529.85	0.00	0.00	0.00	0.00
4	Business Service Input	9882.48	12848.57	11794.99	16365.57	14058.02	20765.32	16944.50	24132.17	19450.53	27662.38	23153.41	15730.00	12945.79	16046.00	12820.75
	Total Overhead Input	10840.77	14048.51	12941.28	17815.97	15402.10	22713.48	18709.40	26510.48	21642.28	30365.43	25760.43	17305.00	14520.79	17693.00	14467.75

Appendix 6.11

Revaluation of Overhead Input of Tech Mahindra Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	52.20	55.00	48.29	60.00	49.14	120.40	92.11	119.20	97.15	129.30	131.11	136.70	139.02	136.10	128.07
2	Depreciation and Amortisation	138.30	150.50	150.50	157.00	157.00	427.00	427.00	473.30	473.30	545.50	545.50	622.20	622.20	656.20	656.20
3	Repairs and Maintenance	48.90	51.10	46.91	51.20	43.98	149.00	121.58	191.00	153.95	221.80	185.65	249.50	205.34	249.10	199.03
4	Business Service Input	1990.10	2053.20	1884.84	2198.50	1888.51	5492.90	4482.21	8385.40	6758.63	9794.90	8198.33	11363.00	9351.75	11266.70	9002.09
	Total Overhead Input	2229.50	2309.80	2130.54	2466.70	2138.63	6189.30	5122.90	9168.90	7483.03	10691.50	9060.59	12371.40	10318.31	12308.10	9985.39

Appendix 6.12

Revaluation of Overhead Input of Wipro Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	200.50	233.40	204.93	230.40	188.70	246.80	188.80	242.60	197.72	249.20	252.69	0.00	0.00	0.00	0.00
2	Depreciation and Amortisation	600.10	746.10	746.10	701.30	701.30	736.70	736.70	778.40	778.40	868.80	868.80	1047.70	1047.70	1014.80	1014.80
3	Repairs and Maintenance	152.40	456.40	418.98	354.50	304.52	399.10	325.67	35.50	28.61	20.30	16.99	0.00	0.00	0.00	0.00
4	Business Service Input	5475.30	6908.80	6342.28	7120.70	6116.68	8116.00	6622.66	9463.40	7627.50	11326.80	9480.53	12285.60	10111.05	12472.70	9965.69
	Total Overhead Input	6428.30	8344.70	7712.28	8406.90	7311.19	9498.60	7873.82	10519.90	8632.23	12465.10	10619.01	13333.30	11158.75	13487.50	10980.49

Appendix 6.13 to 6.16 Revaluation of Overhead Input of Metals Sector Companies

Appendix 6.13

Revaluation of Overhead Input of Coal India Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	6.20	5.45	4.79	6.83	5.59	6.88	5.26	8.03	6.54	10.89	11.04	11.50	11.70	12.11	11.40
2	Depreciation and Amortisation	6.08	6.96	6.96	4.96	4.96	6.41	6.41	7.17	7.17	15.13	15.13	17.52	17.52	18.14	18.14
3	Repairs and Maintenance	7.06	9.48	8.70	10.06	8.64	7.38	6.02	7.73	6.23	9.58	8.02	13.76	11.32	23.63	18.88
4	Business Service Input	282.80	181.68	166.78	343.82	295.34	362.09	295.47	245.88	198.18	338.30	283.16	369.07	303.74	250.62	200.25
	Total Overhead Input	302.14	203.57	187.23	365.67	314.54	382.76	313.16	268.81	218.12	373.90	317.35	411.85	344.28	304.50	248.66

Appendix 6.14

Revaluation of Overhead Input of Hindalco Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	2221.48	2870.67	2520.45	3073.04	2516.82	3557.61	2721.57	5200.77	4238.63	6508.06	6599.17	5898.67	5998.95	6000.12	5646.11
2	Depreciation and Amortisation	687.48	689.97	689.97	704.20	704.20	823.29	823.29	837.03	837.03	1277.00	1277.00	1427.97	1427.97	1617.31	1617.31
3	Repairs and Maintenance	286.10	256.94	235.87	295.56	253.89	442.54	361.11	527.32	425.02	530.10	443.69	543.21	447.06	620.36	495.67
4	Business Service Input	1115.49	1101.32	1011.01	1431.88	1229.98	1390.35	1134.53	2030.22	1636.36	2175.73	1821.09	3113.20	2562.16	3278.24	2619.31
	Total Overhead Input	4310.55	4918.90	4457.30	5504.68	4704.89	6213.79	5040.50	8595.34	7137.03	10490.89	10140.95	10983.05	10436.14	11516.03	10378.40

Appendix 6.15

Revaluation of Overhead Input of Tata Steel Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	1146.19	1151.44	1010.96	1640.38	1343.47	1928.70	1475.46	1997.59	1628.04	1933.11	1960.17	3541.55	3601.76	3727.46	3507.54
2	Depreciation and Amortisation	1558.49	1990.16	1990.16	2510.17	2510.17	2772.31	2772.31	2704.42	2704.42	2881.17	2881.17	2880.92	2880.92	2925.20	2925.20
3	Repairs and Maintenance	1104.10	1224.03	1123.66	1466.50	1259.72	1808.38	1475.64	1940.95	1564.41	2082.71	1743.23	2352.62	1936.21	2674.40	2136.85
4	Business Service Input	4746.19	6438.59	5910.63	7477.22	6422.93	8153.97	6653.64	8572.46	6909.40	8450.18	7072.80	16746.22	13782.14	12935.31	10335.31
	Total Overhead Input	8554.97	10804.22	10035.41	13094.27	11536.30	14663.36	12377.04	15215.42	12806.26	15347.17	13657.37	25521.31	22201.02	22262.37	18904.90

Appendix 6.16

Revaluation of Overhead Input of Vedanta Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	14.97	15.17	13.32	557.48	456.58	4673.67	3575.36	4433.05	3612.94	4361.42	4422.48	4582.00	4659.89	6643.00	6251.06
2	Depreciation and Amortisation	83.13	83.85	83.85	147.91	147.91	1504.79	1504.79	1011.67	1011.67	1217.97	1217.97	2986.00	2986.00	2842.00	2842.00
3	Repairs and Maintenance	23.15	21.25	19.51	32.07	27.55	264.74	216.03	369.89	298.13	328.25	274.75	493.00	405.74	561.00	448.24
4	Business Service Input	2099.81	2413.28	2215.39	947.05	813.52	2153.93	1757.61	1703.10	1372.70	1728.81	1447.01	3485.00	2868.16	3677.00	2937.92
	Total Overhead Input	2221.06	2533.55	2332.07	1684.51	1445.55	8597.13	7053.78	7517.71	6295.44	7636.45	7362.21	11546.00	10919.79	13723.00	12479.23

Appendix 6.17 to 6.20 Revaluation of Overhead Input of Pharmaceutical Sector Companies

Appendix 6.17

Revaluation of Overhead Input of Cipla Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	164.42	211.32	185.54	211.17	172.95	191.84	146.76	198.19	161.52	207.56	210.47	206.28	209.79	239.01	224.91
2	Depreciation and Amortisation	228.86	282.07	282.07	303.03	303.03	323.61	323.61	433.20	433.20	440.81	440.81	751.38	751.38	529.61	529.61
3	Repairs and Maintenance	127.64	174.99	160.64	98.36	84.49	81.29	66.33	79.51	64.09	88.12	73.76	98.56	81.11	100.78	80.52
4	Business Service Input	1332.07	1321.91	1213.51	1655.07	1421.71	1988.21	1622.38	2321.87	1871.43	2883.48	2413.47	2857.66	2351.85	2848.41	2275.88
	Total Overhead Input	1852.99	1990.29	1841.76	2267.63	1982.17	2584.95	2159.08	3032.77	2530.24	3619.97	3138.51	3913.88	3394.14	3717.81	3110.92

Appendix 6.18

Revaluation of Overhead Input of Dr. Reddy's Laboratories Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	144.60	177.50	155.85	282.60	231.45	258.10	197.45	297.10	242.14	278.10	281.99	296.30	301.34	297.30	279.76
2	Depreciation and Amortisation	247.90	301.10	301.10	312.80	312.80	380.50	380.50	490.20	490.20	649.10	649.10	735.10	735.10	774.10	774.10
3	Repairs and Maintenance	160.40	178.80	164.14	138.10	118.63	175.90	143.53	202.30	163.05	236.70	198.12	282.40	232.42	282.40	225.64
4	Business Service Input	1442.30	1957.10	1796.62	2218.20	1905.43	2762.60	2254.28	2508.50	2021.85	2935.60	2457.10	2559.80	2106.72	2467.70	1971.69
	Total Overhead Input	1995.20	2614.50	2417.70	2951.70	2568.31	3577.10	2975.76	3498.10	2917.24	4099.50	3586.31	3873.60	3375.57	3821.50	3251.19

Appendix 6.19

Revaluation of Overhead Input of Lupin Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	196.83	257.13	225.76	299.76	245.50	309.36	236.66	336.39	274.16	350.35	355.25	334.23	339.91	381.32	358.82
2	Depreciation and Amortisation	104.28	131.96	131.96	150.14	150.14	167.63	167.63	336.79	336.79	305.61	305.61	366.11	366.11	389.81	389.81
3	Repairs and Maintenance	65.91	80.92	74.28	111.05	95.39	129.97	106.06	158.07	127.40	174.95	146.43	222.41	183.04	239.49	191.35
4	Business Service Input	861.22	1058.79	971.97	1372.68	1179.13	1596.15	1302.46	1491.13	1201.85	1835.38	1536.21	2495.69	2053.95	2072.26	1655.74
	Total Overhead Input	1228.24	1528.80	1403.97	1933.63	1670.17	2203.11	1812.80	2322.38	1940.20	2666.29	2343.51	3418.44	2943.02	3082.88	2595.72

Appendix 6.20

Revaluation of Overhead Input of Sun Pharmaceutical Industries Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	39.40	68.76	60.37	93.40	76.49	115.80	88.59	382.52	311.75	370.48	375.67	349.23	355.17	376.17	353.98
2	Depreciation and Amortisation	64.23	75.72	75.72	85.82	85.82	101.94	101.94	660.68	660.68	463.98	463.98	422.28	422.28	432.23	432.23
3	Repairs and Maintenance	34.01	51.32	47.11	73.06	62.76	87.19	71.15	200.60	161.68	200.69	167.98	212.08	174.54	221.41	176.91
4	Business Service Input	562.31	644.24	591.41	450.79	387.23	1079.04	880.50	2647.09	2133.55	2516.01	2105.90	1891.62	1556.80	1646.09	1315.23
	Total Overhead Input	699.95	840.04	774.62	703.07	612.30	1383.97	1142.17	3890.89	3267.67	3551.16	3113.52	2875.21	2508.79	2675.90	2278.34

Appendix 6.21 to 6.24 Revaluation of Overhead Input of Refineries Sector Companies

Appendix 6.21

Revaluation of Overhead Input of Bharat Petroleum Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	475.89	716.08	628.72	904.92	741.13	1196.89	915.62	1736.12	1414.94	1562.32	1584.19	1309.36	1331.62	1749.50	1646.28
2	Depreciation and Amortisation	1655.40	1884.87	1884.87	1926.10	1926.10	2246.82	2246.82	2516.02	2516.02	1854.30	1854.30	1891.32	1891.32	2648.48	2648.48
3	Repairs and Maintenance	537.51	636.83	584.61	790.26	678.83	1008.84	823.21	880.49	709.67	911.59	763.00	954.72	785.73	1095.56	875.35
4	Business Service Input	5342.97	7156.93	6570.06	7482.39	6427.37	8576.55	6998.46	8810.64	7101.38	10155.07	8499.79	9147.54	7528.43	10938.92	8740.20
	Total Overhead Input	8011.77	10394.71	9668.26	11103.67	9773.44	13029.10	10984.12	13943.27	11742.01	14483.28	12701.29	13302.94	11537.10	16432.46	13910.31

Appendix 6.22

Revaluation of Overhead Input of Hindustan Petroleum Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	339.56	518.91	455.60	634.69	519.81	109.50	83.77	168.92	137.67	230.12	233.34	136.85	139.18	354.36	333.45
2	Depreciation and Amortisation	1406.95	1712.93	1712.93	1983.52	1983.52	2201.94	2201.94	1978.76	1978.76	2659.44	2659.44	2535.28	2535.28	2752.75	2752.75
3	Repairs and Maintenance	648.82	685.11	628.93	812.93	698.31	880.69	718.64	1042.72	840.43	1123.81	940.63	1209.97	995.81	1362.76	1088.85
4	Business Service Input	4640.11	5709.64	5241.45	6598.40	5668.03	8106.09	6614.57	8209.19	6616.61	10829.48	9064.27	8442.39	6948.09	9394.11	7505.89
	Total Overhead Input	7035.44	8626.59	8038.91	10029.54	8869.66	11298.22	9618.92	11399.59	9573.47	14842.85	12897.69	12324.49	10618.35	13863.98	11680.94

Appendix 6.23

Revaluation of Overhead Input of Indian Oil Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	1880.24	3801.74	3337.93	5326.93	4362.76	6213.95	4753.67	6123.69	4990.81	4607.87	4672.38	3921.15	3987.81	4776.50	4494.69
2	Depreciation and Amortisation	4546.67	4867.79	4867.79	5200.99	5200.99	5760.09	5760.09	4528.66	4528.66	4852.79	4852.79	6222.97	6222.97	7067.01	7067.01
3	Repairs and Maintenance	1468.63	1715.15	1574.51	2023.37	1738.07	2500.19	2040.16	2788.67	2247.67	3144.42	2631.88	2999.35	2468.47	3644.70	2912.12
4	Business Service Input	10540.88	14034.58	12883.74	14513.48	12467.08	18422.18	15032.50	18319.86	14765.81	23858.37	19969.46	26086.49	21469.18	20739.67	16571.00
	Total Overhead Input	18436.42	24419.26	22663.97	27064.77	23768.90	32896.41	27586.42	31760.88	26532.94	36463.45	32126.51	39229.96	34148.43	36227.88	31044.81

Appendix 6.24

Revaluation of Overhead Input of Reliance Industries Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
1	Power and Fuel	2255.07	4094.00	3594.53	7166.00	5868.95	10153.00	7767.05	12299.00	10023.69	9738.00	9874.33	10150.00	10322.55	13565.00	12764.67
2	Depreciation and Amortisation	13607.58	11394.00	11394.00	9465.00	9465.00	8789.00	8789.00	8488.00	8488.00	9566.00	9566.00	8465.00	8465.00	9580.00	9580.00
3	Repairs and Maintenance	904.05	1026.00	941.87	955.00	820.35	1046.00	853.54	1259.00	1014.75	1387.00	1160.92	1458.00	1199.93	1669.00	1333.53
4	Business Service Input	9427.82	9438.00	8664.08	10924.00	9383.72	9976.00	8140.42	10453.00	8425.12	11688.00	9782.86	13120.00	10797.76	10886.00	8697.91
	Total Overhead Input	26194.52	25952.00	24594.48	28510.00	25538.02	29964.00	25550.00	32499.00	27951.56	32379.00	30384.11	33193.00	30785.24	35700.00	32376.11

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Chapter-7

Overall Productivity

CHAPTER 7

OVERALL PRODUCTIVITY

7.1. Introduction

Productivity is the ratio between the outputs and the inputs. It is a concept which helps the management to take future action. It gives the management an idea that how optimally inputs are being utilized by an organisation or not. Productivity can be classified into two heads one is partial productivity and the other is overall productivity. If the efficiency of an individual aspect is to be measured then it is known as partial productivity. It can be evaluated by taking only one individual aspect to compare with the output. For example, if we want to measure the material productivity then only material input is compared with the output. This is known as the partial productivity. But when all inputs (material, labour, overhead, investor input) are added together and compared with the output, it is known as overall productivity.

Material, labour and overhead inputs have been explained in earlier chapters. Here overall productivity is being calculated by considering the overall input which includes material input, labour input, overhead input and investor input calculated on the basis of average investments. Here investor input means the cost to the company in the form of interest, royalty, profit, etc. It is considered so that the true picture of the company in respect of all the factors of production related to productivity can be analysed.

The content of this chapter is based on the articles published by us in different journals, viz., The Management Accountant, IITM Journal of Business Studies and Productivity Journal. (Reference No. 5 to 7)

7.2. Steps in Measurement of Overall Productivity

Following steps have been taken for the measurement of overall productivity:

1. Revaluation of Investor Input at Base Year Prices.
2. Calculation of Average Investment.

3. Calculation of Base Year Rate of Return.
4. Computation and Analysis of Overall Productivity Ratios and Overall Productivity Indices.
5. Testing Hypotheses.

7.2.1. Revaluation of Investor Input at Base Year Prices

- According to H. S. Davis as quoted by M. Maheshwari, "Investor input is the payment and charges made for the use of property, whether borrowed or owned, which was used in the firms business."
- In simple words, investor input is an additional cost other than material, labour and overhead for which it costs to the company viz., interest, royalty, profit, etc.
- Investor input has been revalued according to the base year prices.
- Investor input is calculated on the basis of average investment and the base year rate of return.
- To find out the investor input, the base year rate of return has been multiplied with the average investment.

7.2.2. Calculation of Average Investment

- According to Grewal (2020), "there are two approaches for calculating the capital employed or investment. One is Liabilities Approach and other is Assets Approach."
- In this present research work Assets Approach is followed. According to it, investment or capital employed includes non-current assets and working capital. Non-current assets includes fixed assets (tangible fixed assets and intangible fixed assets), non-current trade investments (it is assumed that all non-current investments are trade investments unless specified to be non-trade investments), long term loans and advances. Working capital means current assets less current liabilities.
- Investment at the end of the year does not match with the return during the year. Therefore it is recommended that average investment should be used for the calculation of investor input.
- Half of the profit has been deducted from the value of investment to obtain the average investment.

- Fixed assets have been taken on the historical values as shown in the balance sheet of the respective companies.
- Non- current investments, long term loans and advances and other non current assets, current assets, current liabilities, profit are revalued on the basis of wholesale price index.
- Revaluation of average investment and normal investor input for all the companies of different sectors has been shown from the appendix 7.1 to 7.24.

7.2.3. Calculation of Base Year Rate of Return

- Base year rate of return is calculated by considering the base year data.
- Total cost has been deducted from the output to obtain the base year returns. Total cost includes material cost, labour cost and overhead cost. Sector wise rate of return has been calculated by dividing the base year return with the average investment.
- Formula for the calculation of base year rate of return has been summarized below:

  $$\text{Rate of Return (Company Standard)} = \frac{\text{Return}}{\text{Average Investment}} \times 100$$

The base year rate of return based on industry standard for inter-company comparison has been calculated with the help of the following formula:

$$R_I = \frac{R_1 + R_2 + R_3 + R_4}{AI_1 + AI_2 + AI_3 + AI_4} \times 100$$

Where,

R_I = Rate of Return (Industry Standard)

R_1 to R_4 = Rate of Return of Sector Companies

AI_1 to AI_4 = Average Investment of Sector Companies

Appendix 7.25 to 7.30 exhibits the calculated value of rate of return of different sectors in 2010-11.

7.2.4. Computation and Analysis of Overall Productivity Ratios and Overall Productivity Indices.

- Overall productivity ratio means output at base year prices per rupee of overall input. Overall input consists of material, labour, overhead and the investor

input. For calculating this ratio revalued output (Refer Appendix 3.1 to 3.24) is divided by the revalued overall input.

- Investor input based on the industry standard has been used for the purpose of inter-company comparison.
- Overall productivity indices have been calculated assuming base year overall productivity ratio as 100.
- Overall productivity index above 100 indicates the improvement in the productivity as compared to the productivity of the base year while below 100 means low productivity as compared to the base year productivity. Overall productivity ratios and indices have been calculated in the table 7.1 to 7.24.

7.2.5. Testing Hypotheses

The present study considers two hypotheses for the purpose of analyzing the overall productivity ratios and indices.

- **For Intra-company Comparison**: First hypothesis has been developed to measure, analyse and compare the overall productivity indices of the sampled company for the study period.

  Null Hypothesis (H_0): There is no significant difference in the overall productivity indices of the sampled company for the study period and can be represented by straight line trend or line of best fit.

  Alternative Hypothesis (H_1): There is a significant difference in the overall productivity indices of the sampled company for the study period and cannot be represented by straight line trend or line of best fit.

  The acceptance of null hypothesis would conveys that the overall productivity indices of the sampled companies for the study period are approximately equal and can be represented by straight line trend or line of best fit. However, rejection of null hypothesis and acceptance of alternative hypothesis would mean that the overall productivity indices of the sampled company differ in the study period indicates that indices cannot be represented by straight line trend. Above intra-company hypothesis will be tested with the help of chi-square test.

- **For Inter-company Comparison**: Another hypothesis has been developed to study the inter-company relationship i.e. hypothesis developed to measure, analyse and compare the overall productivity ratios of sampled companies.

  Null Hypothesis (H_0): There is no significant difference in the overall productivity ratios of sampled companies.

  Alternative Hypothesis (H_1): There is a significant difference in the overall productivity ratios of sampled companies.

  The acceptance of null hypothesis would manifests that the overall productivity ratios of sampled companies are approximately equal. However, rejection of null hypothesis and acceptance of alternative hypothesis would mean that the overall productivity ratios between the sampled companies differ. Above inter-company hypothesis is to be tested with the help of kruskal wallis one way analysis of variance test.

7.3. Overall Productivity

Overall productivity of six sectors has been analysed in the present study. These six sectors have been selected from the Nifty 50. Detailed analysis has been presented in the following headings:

7.3.1. Overall Productivity of Automobile Sector Companies

Overall productivity of automobile sector companies has been highlighted from table 7.1 to 7.4 from 2010-11 to 2017-18 taking 2010-11 as a base year for revaluation of output and input.

Table 7.1

Overall Productivity of Bajaj Auto Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	16891.95	18399.35	17881.58	17003.01	17842.32	19807.03	18883.71	21190.96
2	Material Input	12175.39	13384.66	12680.41	11659.99	12373.59	12918.76	12367.47	14212.05
3	Labour Input	493.58	498.52	535.25	554.38	643.36	623.62	650.09	677.81
4	Overhead Input	763.67	860.15	964.13	1028.46	1319.35	1576.95	1448.27	1539.86
5	Total Input (Company Standard)	13432.64	14743.33	14179.79	13242.83	14336.30	15119.33	14465.83	16429.72
6	Normal Investor Input @19.79% (Industry Standard)	736.62	924.71	1218.46	1434.08	1627.21	1871.46	2626.81	2871.64
7	Total Input (Industry Standard)	14169.26	15668.04	15398.25	14676.91	15963.51	16990.79	17092.64	19301.36
8	Overall Input Output Ratio (Industry Standard)	0.8388	0.8516	0.8611	0.8632	0.8947	0.8578	0.9052	0.9108
9	Overall Productivity Ratio (Industry Standard)	1.1922	1.1743	1.1613	1.1585	1.1177	1.1658	1.1048	1.0979
10	Overall Productivity Indices (Industry Standard) (O)	100.00	98.50	97.41	97.18	93.75	97.79	92.67	92.09
11	Computed Value /Expected Values (E)	99.79	98.76	97.72	96.69	95.66	94.62	93.59	92.56
12	Chi-Square $(O-E)^2/E$	0.0004	0.0007	0.0010	0.0024	0.0379	0.1056	0.0090	0.0023

Average Overall Productivity Indices = 96.17, a = 96.17, b = -0.52, χ^2 = 0.159, S.D. = 2.74, C.V. = 2.85%

Analysis and Interpretation

Output: The revalued output of Bajaj Auto Ltd. is depicting a choppy trend. The average output amounts to ₹ 18487.49 crore which is higher as compared to the base year which is ₹ 16891.95 crore. It is the highest ₹ 21190.96 crore in 2017-18 and it is the lowest ₹ 16891.95 crore in 2010-11.

Normal Investor Input: Normal investor input calculated at base year industry standard rate of 19.79% is ₹ 736.62 crore in 2010-11, ₹ 924.71 crore in 2011-12, ₹ 1218.46 crore in 2012-13, ₹ 1434.08 crore in 2013-14, ₹ 1627.21 crore in 2014-15, ₹ 1871.46 crore in 2015-16, ₹ 2626.81 crore in 2016-17 and ₹ 2871.64 crore in 2017-18.

Total Input: Total input has been calculated by adding all the inputs may it be a material, labour, overhead or investor input. Total input of Bajaj Auto Ltd. is exhibiting an erratic trend. It is the highest ₹ 19301.36 crore in 2017-18 while it is the lowest ₹ 14169.26 crore in 2010-11. Overall input output ratio is showing an increasing trend except in the year 2015-16. It is the highest 0.9108 in 2017-18 and the lowest 0.8388 in 2010-11.

Overall Productivity Ratio: There is a decreasing trend in the overall productivity ratio of Bajaj Auto Ltd. except in the year 2015-16 which shows an increase in the overall productivity from the preceding year. Overall productivity ratio is 1.1922 in 2010-11, 1.1743 in 2011-12, 1.1613 in 2012-13, 1.1585 in 2013-14, 1.1177 in 2014-15, 1.1658 in 2015-16, 1.1048 in 2016-17 and 1.0979 in 2017-18. It has been clear from the above observation that the overall productivity of Bajaj Auto Ltd. of all the years in greater that 1 this means that more output is generated from less input. Overall productivity ratio is the lowest 1.0979 in 2017-18 while it is the highest 1.1922 in 2010-11. The average overall productivity ratio is 1.1465. Overall efficiency can also be observed from the average of overall indices which worked out to 96.17 as compared to the base year index of 100. It is concluded from the above that the overall efficiency of the company is decreasing.

Testing Hypothesis and Interpretation: The standard deviation and coefficient of variation of Bajaj Auto Ltd. is 2.74 and 2.85% respectively. The computed value of chi-square is 0.159. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of

chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This presents that there is no significant difference in the overall productivity indices of the company for the study period and can be represented by straight line trend or line of best fit.

Table 7.2

Overall Productivity of Mahindra & Mahindra Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	23692.18	29120.78	35143.67	33416.69	31931.62	34755.61	37410.97	39883.51
2	Material Input	16604.88	22269.71	26350.06	24389.79	22416.18	25055.98	26487.90	27261.69
3	Labour Input	1431.52	1570.74	1562.22	1650.92	1661.24	1590.32	1769.81	1801.12
4	Overhead Input	2585.62	3065.53	3509.91	4123.23	4055.18	4709.15	5342.03	5754.01
5	Total Input (Company Standard)	20622.02	26905.98	31422.19	30163.94	28132.60	31355.45	33599.73	34816.82
6	Normal Investor Input @ 19.79 % (Industry Standard)	2425.72	2827.95	3158.92	3592.25	3869.91	4304.81	4987.57	5483.64
7	Total Input (Industry Standard)	23047.74	29733.93	34581.11	33756.19	32002.51	35660.26	38587.30	40300.46
8	Overall Input Output Ratio (Industry Standard)	0.9728	1.0211	0.9840	1.0102	1.0022	1.0260	1.0314	1.0105
9	Overall Productivity Ratio (Industry Standard)	1.0280	0.9794	1.0163	0.9899	0.9978	0.9746	0.9695	0.9897
10	Overall Productivity Indices (Industry Standard) (O)	100.00	95.27	98.86	96.30	97.06	94.81	94.31	96.27
11	Computed Value /Expected Values (E)	98.37	97.87	97.37	96.86	96.36	95.86	95.35	94.85
12	Chi-Square $(O-E)^2/E$	0.0269	0.0689	0.0229	0.0033	0.0051	0.0114	0.0114	0.0213

Average Overall Productivity Indices = 96.61, a = 96.61, b = - 0.25, χ^2 = 0.171, S.D. = 1.85, C.V. = 1.91%

Analysis and Interpretation

Output: The revalued output of Mahindra & Mahindra Ltd. is ₹ 23692.18 crore in 2010-11, ₹ 29120.78 crore in 2011-12, ₹ 35143.67 crore in 2012-13, ₹ 33416.69 crore in 2013-14, ₹ 31931.62 crore in 2014-15, ₹ 34755.61 crore in 2015-16, ₹ 37410.97 crore in 2016-17, ₹ 39883.51 crore in 2017-18. The average output for the study period is ₹ 33169.38 crore.

Normal Investor Input: Normal investor input is showing an increasing trend. It is ₹ 2425.72 crore in 2010-11 and reached to ₹ 5483.64 crore in 2017-18. The average investor input is ₹ 3831.35 crore.

Total Input: All material, labour, overhead and investor input have been added to find out the total input. Total input of Mahindra & Mahindra Ltd. is the highest ₹ 40300.46 crore in 2017-18 and it is the lowest ₹ 23047.74 crore in 2010-11 while average input is ₹ 33458.69 crore. Total input of the year 2010-11, 2011-12 and 2014-15 is lower than the average input while remaining are higher than the average. Overall input output ratio is the lowest 0.9728 in 2010-11 while it is the highest 1.0314 in 2016-17 and maintaining the average ratio to 1.0073.

Overall Productivity Ratio: There is an inconsistent trend in the overall productivity ratios of Mahindra & Mahindra Ltd. Overall productivity ratio is 1.0280 in 2010-11, 0.9794 in 2011-12, 1.0163 in 2012-13, 0.9899 in 2013-14, 0.9978 in 2014-15, 0.9746 in 2015-16, 0.9695 in 2016-17 and 0.9897 in 2017-18. Overall productivity ratio is the lowest 0.9695 in 2016-17 while it is the highest 1.0280 in 2010-11. The average overall productivity ratio is 0.9931. Overall efficiency can also be observed from the average of overall indices which worked out to 96.61 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation and coefficient of variation is 1.85 and 1.91% respectively. The computed value of chi-square of Mahindra & Mahindra Ltd. is 0.171. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This shows that the overall productivity ratios of the company for the study period are approximately same that is there is no significant difference in the overall productivity indices of the company and can be represented by straight line trend or line of best fit.

Table 7.3

Overall Productivity of Maruti Suzuki India Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	37071.20	33307.52	38159.96	36346.27	40579.12	48726.04	57572.80	65397.27
2	Material Input	28490.10	26007.50	28108.20	25699.92	28784.76	32682.60	38957.36	44081.23
3	Labour Input	703.60	778.83	895.26	1043.86	1151.93	1350.33	1519.81	1796.63
4	Overhead Input	4855.70	4829.59	6603.15	6724.15	7630.19	9412.23	9612.67	10568.61
5	Total Input (Company Standard)	34049.40	31615.92	35606.61	33467.93	37566.88	43445.16	50089.84	56446.47
6	Normal Investor Input @ 19.79% (Industry Standard)	2624.57	2845.60	3525.33	3890.91	4191.27	4688.08	6103.98	6951.45
7	Total Input (Industry Standard)	36673.97	34461.52	39131.94	37358.84	41758.15	48133.24	56193.82	63397.92
8	Overall Input Output Ratio (Industry Standard)	0.9893	1.0346	1.0255	1.0279	1.0291	0.9878	0.9760	0.9694
9	Overall Productivity Ratio (Industry Standard)	1.0108	0.9665	0.9752	0.9729	0.9718	1.0123	1.0245	1.0315
10	Overall Productivity Indices (Industry Standard) (O)	100.00	95.62	96.47	96.25	96.14	100.15	101.36	102.05
11	Computed Value /Expected Values (E)	96.25	96.90	97.54	98.18	98.82	99.47	100.11	100.75
12	Chi-Square $(O-E)^2/E$	0.1458	0.0169	0.0117	0.0381	0.0731	0.0047	0.0156	0.0167

Average Overall Productivity Indices = 98.50, a = 98.50, b = 0.32, χ^2 = 0.323, S.D. = 2.47, C.V. = 2.51 %

Analysis and Interpretation

Output: The output of Maruti Suzuki India Ltd. is changeful in nature. It is the highest ₹ 65397.27 crore in 2017-18 and it is the lowest ₹ 33307.52 crore in 2011-12.

Normal Investor Input: Normal investor input calculated at base year industry standard rate of 19.79% is ₹ 2624.57 crore in 2010-11, ₹ 2845.60 crore in 2011-12, ₹ 3525.33 crore in 2012-13, ₹ 3890.91 crore in 2013-14, ₹ 4191.27 crore in 2014-15, ₹ 4688.08 crore in 2015-16, ₹ 6103.98 crore in 2016-17 and ₹ 6951.45 crore in 2017-18. Average investor input worked out as ₹ 4352.65 crore.

Total Input: Total input has been calculated by adding all the inputs. It is the highest ₹ 63397.92 crore in 2017-18 while it is the lowest ₹ 34461.52 crore in 2011-12. Overall input output ratio is showing an erratic trend. It is the highest 1.0346 in 2011-12 and the lowest 0.9694 in 2017-18.

Overall Productivity Ratio: It is 1.0108 in 2010-11, 0.9665 in 2011-12, 0.9752 in 2012-13, 0.9729 in 2013-14, 0.9718 in 2014-15, 1.0123 in 2015-16, 1.0245 in 2016-17 and 1.0315 in 2017-18. Overall productivity ratio of Maruti Suzuki India Ltd. is the lowest 0.9665 in 2011-12 while it is the highest 1.0315 in 2017-18. Its average overall productivity ratio is 0.9957 which is less than 1. Overall efficiency can also be observed from the average of overall indices which worked out to 98.50 as compared to the base year index of 100. It is concluded from the above that the overall efficiency of the company is decreasing.

Testing Hypothesis and Interpretation: The standard deviation and coefficient of variation is 2.47 and 2.51% respectively. In Maruti Suzuki India Ltd. the computed value of chi-square is 0.323. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that there is no significant difference in the overall productivity indices of the company and can be represented by straight line trend or line of best fit.

Table 7.4

Overall Productivity of Tata Motors Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	47157.19	49807.74	40124.16	31410.17	30067.20	37267.99	37072.17	48923.62
2	Material Input	35047.05	37713.08	29003.62	21249.12	22864.47	25146.23	26542.76	33943.29
3	Labour Input	2294.02	2484.21	2374.57	2195.68	2216.58	2055.16	2454.36	2514.91
4	Overhead Input	6797.22	7991.99	7467.30	6872.26	8215.45	8351.58	9052.54	9742.94
5	Total Input (Company Standard)	44138.29	48189.28	38845.49	30317.06	33296.49	35552.97	38049.66	46201.13
6	Normal Investor Input @ 19.79% (Industry Standard)	6784.86	6061.93	5817.54	5749.16	6023.84	6438.07	7304.36	6701.68
7	Total Input (Industry Standard)	50923.15	54251.21	44663.03	36066.22	39320.33	41991.04	45354.02	52902.81
8	Overall Input Output Ratio (Industry Standard)	1.0799	1.0892	1.1131	1.1482	1.3077	1.1267	1.2234	1.0813
9	Overall Productivity Ratio (Industry Standard)	0.9260	0.9181	0.8984	0.8709	0.7647	0.8875	0.8174	0.9248
10	Overall Productivity Indices (Industry Standard) (O)	100.00	99.14	97.01	94.05	82.57	95.84	88.27	99.86
11	Computed Value /Expected Values (E)	97.52	96.69	95.85	95.01	94.17	93.34	92.50	91.66
12	Chi-Square $(O-E)^2/E$	0.0629	0.0624	0.0141	0.0098	1.4289	0.0671	0.1937	0.7336

Average Overall Productivity Indices = 94.59, a = 94.59, b = - 0.42, χ^2 = 2.573, S.D. = 5.81, C.V. = 6.14 %

Analysis and Interpretation

Output: The revalued output of Tata Motors Ltd. is the highest ₹ 49807.74 crore in 2011-12 while it is the lowest ₹ 30067.20 crore in 2014-15.

Normal Investor Input: Normal investor input calculated at base year industry standard rate 19.79% is ₹ 6784.86 crore in 2010-11 and reached to ₹ 6701.68 crore in 2017-18. Average investor input worked out as ₹ 6360.18 crore.

Total Input: Total input of Tata Motors Ltd. is exhibiting a choppy trend. It is the highest ₹ 54251.21 crore in 2011-12 while it is the lowest ₹ 36066.22 crore in 2013-14. Overall input output ratio is the highest 1.3077 in 2014-15 and the lowest 1.0799 in 2010-11.

Overall Productivity Ratio: Overall productivity ratio is 0.9260 in 2010-11, 0.9181 in 2011-12, 0.8984 in 2012-13, 0.8709 in 2013-14, 0.7647 in 2014-15, 0.8875 in 2015-16, 0.8174 in 2016-17 and 0.9248 in 2017-18. It has been clear from the above observation that the overall productivity of Tata Motors Ltd. of all the years in less than one, this means that less output is generated from more input. Overall productivity ratio is the lowest 0.7647 in 2014-15 while it is the highest 0.9260 in 2010-11. The average overall productivity ratio is 0.8760. Overall efficiency can also be observed from the average of overall indices which worked out to 94.59 as compared to the base year index of 100 indicates less efficiency.

Testing Hypothesis and Interpretation: The standard deviation and coefficient of variation is 5.81 and 6.14% respectively. The computed value of chi-square of Tata Motors Ltd. is 2.573. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This manifests that there is no significant difference in the overall productivity indices of the company for the study period and can be represented by straight line trend or line of best fit.

7.3.2 Overall Productivity of Energy Sector Companies

Overall productivity of energy sector companies have been depicted from table 7.5 to 7.8 from 2010-11 to 2017-18 taking 2010-11 as a base year for revaluation.

Table 7.5

Overall Productivity of GAIL (India) Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	32844.73	37024.85	41429.76	47148.15	46615.02	44514.51	40629.38	43636.95
2	Material Input	23994.13	28644.08	31493.44	37881.50	36776.93	35230.22	30199.45	32632.33
3	Labour Input	721.23	560.70	657.42	646.82	649.89	676.32	819.91	825.13
4	Overhead Input	3071.50	3750.14	4076.95	4487.22	5245.97	5143.92	4849.36	4849.86
5	Total Input (Company Standard)	27786.86	32954.93	36227.81	43015.54	42672.79	41050.46	35868.72	38307.32
6	Normal Investor Input @ 16.04% (Industry Standard)	3429.87	4275.18	5246.88	5850.02	6302.09	6309.91	6835.79	6910.38
7	Total Input (Industry Standard)	31216.73	37230.11	41474.69	48865.56	48974.88	47360.37	42704.51	45217.70
8	Overall Input Output Ratio (Industry Standard)	0.9504	1.0055	1.0011	1.0364	1.0506	1.0639	1.0511	1.0362
9	Overall Productivity Ratio (Industry Standard)	1.0522	0.9945	0.9989	0.9649	0.9518	0.9399	0.9514	0.9650
10	Overall Productivity Indices (Industry Standard) (O)	100.00	94.52	94.94	91.70	90.46	89.33	90.42	91.72
11	Computed Value /Expected Values (E)	96.91	95.76	94.61	93.46	92.31	91.16	90.02	88.87
12	Chi-Square $(O-E)^2/E$	0.0986	0.0161	0.0011	0.0331	0.0371	0.0368	0.0019	0.0916

Average Overall Productivity Indices = 92.89, a = 92.89, b = - 0.57, χ^2 = 0.316, S.D. = 3.26, C.V. = 3.51 %

Analysis and Interpretation

Output: The revalued output of GAIL (India) Ltd. is ₹ 32844.73 crore in 2010-11 and reached to ₹ 43636.95 crore in 2017-18. It is the highest ₹ 47148.15 crore in 2013-14 while it is the lowest ₹ 32844.73 crore in 2010-11.

Normal Investor Input: Normal investor input is demonstrating an increasing trend. It is the lowest ₹ 3429.87 crore in 2010-11 as compared to the highest ₹ 6910.38 crore in 2017-18.

Total Input: Total input is ₹ 31216.73 crore in 2010-11, increased and reached to ₹ 48974.88 crore in 2014-15 then it slightly decreased and reached to ₹ 42704.51 crore in 2016-17 and ultimately reached to ₹ 45217.70 crore in 2017-18. Overall

input output ratio is the highest 1.0639 in 2015-16 while it is the lowest 0.9504 in 2010-11.

Overall Productivity Ratio: Overall productivity ratio portrays a changeable trend. It is 1.0522 in 2010-11, 0.9945 in 2011-12, 0.9989 in 2012-13, 0.9649 in 2013-14, 0.9518 in 2014-15, 0.9399 in 2015-16, 0.9514 in 2016-17 and 0.9650 in 2017-18. Overall productivity ratio is the lowest 0.9399 in 2015-16 while it is the highest 1.0522 in 2010-11. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overall inputs has not been utilized efficiently as compared to the other years but in this case in the year 2010-11, it is greater than one depicts more output from less input. Overall efficiency can also be analysed from the average of overall indices which worked out to 92.89 as compared to the base year index of 100 of 2010-11.

Testing Hypothesis and Interpretation: The standard deviation and coefficient of variation of GAIL (India) Ltd. is 3.26 and 3.51% respectively. The computed value of chi-square is 0.316. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence, null hypothesis is accepted and alternative hypothesis is rejected. This unveils that the overall productivity indices of GAIL (India) Ltd. for the study period are approximately equal and can be represented by straight line trend or line of best fit.

Table 7.6

Overall Productivity of NTPC Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	57407.30	59514.54	59078.16	60961.58	60721.91	60009.61	65298.71	68081.15
2	Material Input	35405.11	38262.88	35274.49	37435.88	39398.82	36700.06	39199.22	39712.37
3	Labour Input	2789.71	2852.51	2812.42	2951.28	2596.05	2450.73	2819.64	3001.78
4	Overhead Input	7380.64	6023.23	6948.66	7776.42	8837.08	10350.85	10212.86	13133.28
5	Total Input (Company Standard)	45575.46	47138.63	45035.57	48163.58	50831.95	49501.63	52231.71	55847.43
6	Normal Investor Input @ 16.04% (Industry Standard)	17186.31	18605.31	20335.04	22765.32	24926.62	27580.74	30751.22	33473.51
7	Total Input (Industry Standard)	62761.77	65743.94	65370.61	70928.90	75758.57	77082.37	82982.93	89320.94
8	Overall Input Output Ratio (Industry Standard)	1.0933	1.1047	1.1065	1.1635	1.2476	1.2845	1.2708	1.3120
9	Overall Productivity Ratio (Industry Standard)	0.9147	0.9052	0.9037	0.8595	0.8015	0.7785	0.7869	0.7622
10	Overall Productivity Indices (Industry Standard) (O)	100.00	98.97	98.80	93.96	87.63	85.11	86.03	83.33
11	Computed Value /Expected Values (E)	101.26	98.54	95.81	93.09	90.37	87.64	84.92	82.20
12	Chi-Square $(O-E)^2/E$	0.0157	0.0019	0.0932	0.0082	0.0831	0.0731	0.0145	0.0156

Average Overall Productivity Indices = 91.73, a = 91.73, b = -1.36, χ^2 = 0.305, S.D. = 6.51, C.V. = 7.10 %

Analysis and Interpretation

Output: The revalued output of NTPC Ltd. is ₹ 57407.30 crore in 2010-11 which is the lowest and reached to ₹ 68081.15 crore in 2017-18 which is the highest.

Normal Investor Input: It is reflecting an increasing trend with the highest ₹ 33473.51 crore in 2017-18 and the lowest ₹ 17186.31 crore in 2010-11.

Total Input: Total input is also elaborating an increasing trend except in the year 2012-13. It is ₹ 62761.77 crore in 2010-11 and reached to ₹ 89320.94 crore in 2017-18. Overall input output ratio is the highest 1.3120 in 2017-18 while it is the lowest 1.0933 in 2010-11.

Overall Productivity Ratio: Overall productivity ratio is depicting a decreasing trend with the highest 0.9147 in 2010-11 and the lowest 0.7622 in 2017-18. Overall efficiency can also be observed from the average of overall indices which worked out as 91.73.

Testing Hypothesis and Interpretation: The standard deviation of NTPC Ltd. is 6.51 with coefficient of variation 7.10% indicated the variability. The computed value of chi-square is 0.305. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reveals that the overall productivity indices of the NTPC Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 7.7

Overall Productivity of Oil and Natural Gas Corporation Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	71732.86	74244.84	75951.96	74017.52	70984.50	70792.55	70326.36	74166.87
2	Material Input	2790.68	2250.00	3607.07	4184.32	3995.40	4432.38	5014.43	4487.08
3	Labour Input	6728.21	6272.75	8646.34	7939.05	6187.63	5935.34	7531.10	7215.59
4	Overhead Input	34562.07	36513.06	39787.20	38344.62	42855.89	39728.04	37426.99	40789.64
5	Total Input (Company Standard)	44080.96	45035.82	52040.61	50467.98	53038.92	50095.76	49972.52	52492.31
6	Normal Investor Input @ 16.04% (Industry Standard)	19151.57	20736.28	22827.63	25404.31	26797.17	29012.87	32632.62	34395.53
7	Total Input (Industry Standard)	63232.53	65772.10	74868.24	75872.29	79836.09	79108.63	82605.14	86887.84
8	Overall Input Output Ratio (Industry Standard)	0.8815	0.8859	0.9857	1.0251	1.1247	1.1175	1.1746	1.1715
9	Overall Productivity Ratio (Industry Standard)	1.1344	1.1288	1.0145	0.9756	0.8891	0.8949	0.8514	0.8536
10	Overall Productivity Indices (Industry Standard) (O)	100.00	99.51	89.43	86.00	78.38	78.88	75.05	75.24
11	Computed Value /Expected Values (E)	99.26	95.27	91.29	87.30	83.32	79.33	75.34	71.36
12	Chi-Square $(O-E)^2/E$	0.0055	0.1879	0.0380	0.0196	0.2929	0.0025	0.0012	0.2116

Average Overall Productivity Indices = 85.31, a = 85.31, b = - 1.99, χ^2 = 0.759, S.D. = 9.56, C.V. = 11.20 %

Analysis and Interpretation

Output: The output of Oil and Natural Gas Corporation Ltd. ranges between ₹ 70326.36 crore and ₹ 75951.96 crore.

Normal Investor Input: It is conveying an increasing trend with the lowest ₹ 19151.57 crore in 2010-11 and the highest ₹ 34395.53 crore in 2017-18.

Total Input: Total input is depicting an increasing trend except in the year 2015-16. It is the lowest ₹ 63232.53 crore in 2010-11 as compared to the highest ₹ 86887.84 crore in 2017-18. Overall input output ratio is the highest 1.1746 in 2016-17 while it is the lowest 0.8815 in 2010-11. The lowest overall input output ratio means overall input has been best utilized in 2010-11.

Overall Productivity Ratio: Overall productivity ratio of Oil and Natural Gas Corporation Ltd. is 1.1344 in 2010-11, 1.1288 in 2011-12, 1.0145 in 2012-13, 0.9756 in 2013-14, 0.8891 in 2014-15, 0.8949 in 2015-16, 0.8514 in 2016-17 and 0.8536 in 2017-18. The highest ratio 1.1344 in 2010-11 indicates efficiency and effectiveness while the lowest ratio 0.8514 in 2016-17 indicates that the overall input has not been utilized efficiently. The average of overall indices worked out as 85.31 which is lower than the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation and coefficient of variation of Oil and Natural Gas Corporation Ltd. is 9.56 and 11.20% respectively. The computed value of chi-square is 0.759. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reflects that the overall productivity ratios of the company for the study period of eight years are approximately same and can be represented by straight line trend or line of best fit.

Table 7.8

Overall Productivity of Power Grid Corporation of India Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	9098.75	9900.64	11449.39	12828.67	14330.71	17812.35	21872.62	24582.29
2	Material Input	0.03	0.05	54.62	179.08	0.82	3.84	3.23	6.93
3	Labour Input	745.89	778.06	741.92	718.50	733.96	665.79	897.89	1018.13
4	Overhead Input	2898.29	3312.83	4096.26	4897.49	6178.38	7497.04	9130.13	10883.85
5	Total Input (Company Standard)	3644.21	4090.93	4892.80	5795.08	6913.16	8166.67	10031.25	11908.91
6	Normal Investor Input @ 16.04% (Industry Standard)	10243.17	12179.26	14767.16	18454.18	21271.35	23979.66	26693.89	29107.24
7	Total Input (Industry Standard)	13887.38	16270.19	19659.96	24249.26	28184.51	32146.33	36725.14	41016.15
8	Overall Input Output Ratio (Industry Standard)	1.5263	1.6433	1.7171	1.8902	1.9667	1.8047	1.6790	1.6685
9	Overall Productivity Ratio (Industry Standard)	0.6552	0.6085	0.5824	0.5290	0.5085	0.5541	0.5956	0.5993
10	Overall Productivity Indices (Industry Standard) (O)	100.00	92.88	88.89	80.75	77.61	84.57	90.90	91.48
11	Computed Value /Expected Values (E)	91.95	90.93	89.91	88.89	87.87	86.85	85.83	84.82
12	Chi-Square $(O-E)^2/E$	0.7045	0.0416	0.0117	0.7467	1.1997	0.0600	0.2992	0.5230

Average Overall Productivity Indices = 88.38, a = 88.38, b = -0.51, χ^2 = 3.586, S.D. = 6.71, C.V. = 7.59 %

Analysis and Interpretation

Output: The output of Power Grid Corporation of India Ltd. is highlighting an increasing trend with ₹ 9098.75 crore in 2010-11 and reached to ₹ 24582.29 crore in 2017-18.

Normal Investor Input: It is portraying an increasing trend. It is the maximum ₹ 29107.24 crore in 2017-18 as compared to the minimum ₹ 10243.17 crore in 2010-11.

Total Input: Total input is having an increasing trend with the lowest ₹ 13887.38 crore in 2010-11 as compared to the highest ₹ 41016.15 crore in 2017-18. Overall input output ratio is the highest 1.9667 in 2014-15 while it is the lowest 1.5263 in 2010-11. The lowest overall input output ratio means overall input is best utilized in 2010-11.

Overall Productivity Ratio: Overall productivity ratio of Power Grid Corporation of India Ltd. is 0.6552 in 2010-11 and reached to 0.5993 in 2017-18. It is the lowest 0.5085 in 2014-15 while it is the highest 0.6552 in 2010-11. The higher ratio indicates efficiency and effectiveness. The average of overall indices calculated is 88.38 which is lower than the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation and coefficient of variation of overall productivity in Power Grid Corporation of India Ltd. is 6.71 and 7.59% respectively. The computed value of chi-square is 3.586 as compared to the table value of 14.067. As the calculated value of chi-square is less as

compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This discloses that the overall productivity ratios of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

7.3.3. Overall Productivity of Information Technology Sector Companies

Overall productivity of information technology sector companies has been shown from table 7.9 to 7.12.

Table 7.9

Overall Productivity of Infosys Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	26532.00	30814.51	33555.12	38284.27	40813.42	47702.30	51314.87	52702.04
2	Material Input	482.00	595.78	649.40	767.86	820.51	901.45	1041.92	1032.31
3	Labour Input	12459.00	14281.58	16683.08	18579.05	18007.46	19151.87	20175.49	20587.25
4	Overhead Input	4770.00	5443.02	5297.06	6414.54	6721.90	8626.95	9490.58	10124.12
5	Total Input (Company Standard)	17711.00	20320.38	22629.55	25761.44	25549.86	28680.28	30707.98	31743.68
6	Normal Investor Input @ 38.48% (Industry Standard)	8197.97	9036.04	10526.50	11843.11	13183.05	15971.19	19578.73	17454.79
7	Total Input (Industry Standard)	25908.97	29356.42	33156.05	37604.55	38732.91	44651.47	50286.71	49198.47
8	Overall Input Output Ratio (Industry Standard)	0.9765	0.9527	0.9881	0.9822	0.9490	0.9360	0.9800	0.9335
9	Overall Productivity Ratio (Industry Standard)	1.0240	1.0497	1.0120	1.0181	1.0537	1.0683	1.0204	1.0712
10	Overall Productivity Indices (Industry Standard) (O)	100.00	102.50	98.83	99.42	102.90	104.32	99.65	104.61
11	Computed Value /Expected Values (E)	99.95	100.40	100.85	101.30	101.75	102.21	102.66	103.11
12	Chi-Square $(O-E)^2/E$	0.0000	0.0441	0.0406	0.0351	0.0129	0.0439	0.0882	0.0217

Average Overall Productivity Indices = 101.53, a = 101.53, b = 0.23, χ^2 = 0.286, S.D. = 2.17, C.V. = 2.14 %.

Analysis and Interpretation

Output: The revalued output of Infosys Ltd. has an increasing trend. It is ₹ 26532.00 crore in 2010-11 and reached to ₹ 52702.04 crore in 2017-18.

Normal Investor Input: It is ₹ 8197.97 crore in 2010-11, increased and reached to ₹ 19578.73 crore in 2016-17 then slightly decreased and reached to ₹ 17454.79 crore in 2017-18.

Total Input: Total input of Infosys Ltd. is ₹ 25908.97 crore in 2010-11, ₹ 29356.42 crore in 2011-12, ₹ 33156.05 crore in 2012-13, ₹ 37604.55 crore in 2013-14, ₹ 38732.91 crore in 2014-15, ₹ 44651.47 crore in 2015-16, ₹ 50286.71 crore in 2016-17 and ₹ 49198.47 crore in 2017-18. The overall input output ratio is the lowest in the year 2017-18 with 0.9335 while it is the highest 0.9881 in 2012-13. This means overall input of Infosys Ltd. is best utilized in the year 2017-18.

Overall Productivity Ratio: Overall productivity ratio is the lowest 1.0120 in 2012-13 while it is the highest 1.0712 in 2017-18. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overall input has not been utilized efficiently. Improvement in overall efficiency can also be observed from the average of overall indices which worked out to 101.53 as compared to the base year index of 100 which is slightly higher than the base year.

Testing Hypothesis and Interpretation: The standard deviation of Infosys Ltd. is 2.17 with 2.14% of variability. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square is 0.286. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This indicates that the overall productivity indices of Infosys Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 7.10

Overall Productivity of Tata Consultancy Services Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	29771.01	38137.37	43513.96	55314.66	62904.22	74998.91	80044.98	82424.84
2	Material Input	17.75	10.84	21.51	32.47	52.13	33.34	1447.66	1602.00
3	Labour Input	10190.31	13014.68	14297.40	16378.99	19623.09	20416.30	31371.63	32650.37
4	Overhead Input	10840.77	12941.28	15402.10	18709.40	21642.28	25760.43	14520.79	14467.75
5	Total Input (Company Standard)	21048.83	25966.80	29721.01	35120.85	41317.50	46210.07	47340.08	48720.12
6	Normal Investor Input @ 38.48% (Industry Standard)	6197.68	7214.48	9278.16	11971.19	12266.20	16339.72	22020.57	20619.08
7	Total Input (Industry Standard)	27246.51	33181.28	38999.17	47092.04	53583.70	62549.79	69360.65	69339.20
8	Overall Input Output Ratio (Industry Standard)	0.9152	0.8700	0.8962	0.8513	0.8518	0.8340	0.8665	0.8412
9	Overall Productivity Ratio (Industry Standard)	1.0927	1.1494	1.1158	1.1746	1.1739	1.1990	1.1540	1.1887
10	Overall Productivity Indices (Industry Standard) (O)	100.00	105.19	102.12	107.50	107.44	109.74	105.62	108.79
11	Computed Value /Expected Values (E)	102.20	103.22	104.25	105.28	106.31	107.34	108.37	109.40
12	Chi-Square $(O-E)^2/E$	0.0472	0.0374	0.0439	0.0467	0.0119	0.0533	0.0700	0.0034

Average Overall Productivity Indices = 105.80, a = 105.80, b = 0.51, χ^2 = 0.314, S.D. = 3.12, C.V. = 2.94 %.

Analysis and Interpretation

Output: The output of Tata Consultancy Services Ltd. is the lowest in the year 2010-11 with ₹ 29771.01 crore and it is the highest ₹ 82424.84 crore in 2017-18.

Normal Investor Input: The normal investor input element of total input is ₹ 6197.68 crore in 2010-11 and reached to ₹ 20619.08 crore in 2017-18.

Total Input: Total input is the highest ₹ 69360.65 crore in 2016-17 and it is the lowest ₹ 27246.51 crore in 2010-11. Its input output ratio is the lowest 0.8340 in 2015-16 and the highest 0.9152 in 2010-11.

Overall Productivity Ratio: Overall productivity ratio is the lowest 1.0927 in 2010-11 suggesting that the overall input has not been properly utilized while it is the highest 1.1990 in 2015-16 represents efficiency in the utilisation of overall input. Improvement in overall efficiency can also be observed from the average of overall indices which worked out as 105.80.

Testing Hypothesis and Interpretation: The standard deviation of Tata Consultancy Services Ltd. is 3.12 with 2.94% of variability. For testing the hypothesis chi-square method has been used. The table value is 14.067 while the calculated value of chi-square is 0.314. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This discloses that the overall productivity ratios of the company for the eight years study period are the same and can be represented by straight line trend or line of best fit.

Table 7.11

Overall Productivity of Tech Mahindra Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	5092.10	4875.22	5073.86	13354.17	15545.48	18479.45	19799.98	20288.13
2	Material Input	1.50	0.46	0.00	0.00	0.00	0.00	0.00	0.00
3	Labour Input	1943.80	2077.67	2104.05	5319.25	5163.26	5031.46	5049.35	5139.52
4	Overhead Input	2229.50	2130.54	2138.63	5122.90	7483.03	9060.59	10318.31	9985.39
5	Total Input (Company Standard)	4174.80	4208.67	4242.68	10442.15	12646.29	14092.05	15367.66	15124.92
6	Normal Investor Input @ 38.48% (Industry Standard)	1617.14	1585.10	1545.49	3030.11	3813.95	4592.07	5741.39	6347.51
7	Total Input (Industry Standard)	5791.94	5793.77	5788.17	13472.26	16460.24	18684.12	21109.05	21472.43
8	Overall Input Output Ratio (Industry Standard)	1.1374	1.1884	1.1408	1.0088	1.0588	1.0111	1.0661	1.0584
9	Overall Productivity Ratio (Industry Standard)	0.8792	0.8415	0.8766	0.9912	0.9444	0.9890	0.9380	0.9448
10	Overall Productivity Indices (Industry Standard) (O)	100.00	95.71	99.71	112.75	107.42	112.50	106.69	107.47
11	Computed Value /Expected Values (E)	99.44	101.11	102.78	104.45	106.12	107.78	109.45	111.12
12	Chi-Square $(O-E)^2/E$	0.0032	0.2880	0.0917	0.6597	0.0161	0.2061	0.0698	0.1201

Average Overall Productivity Indices = 105.28, a = 105.28, b = 0.83, χ^2 = 1.455, S.D. = 5.81, C.V. = 5.52 %.

Analysis and Interpretation

Output: The output of Tech Mahindra Ltd. is having an increasing trend except in the year 2011-12. It is ₹ 5092.10 crore in the year 2010-11 and reached to ₹ 20288.13 crore in 2017-18.

Normal Investor Input: The normal investor input of total input of Tech Mahindra Ltd. is the lowest ₹ 1545.49 crore in 2012-13 and the highest ₹ 6347.51 crore in 2017-18.

Total Input: Total input of Tech Mahindra Ltd. is ₹ 5791.94 crore in 2010-11, ₹ 5793.77 crore in 2011-12, ₹ 5788.17 in 2012-13, ₹ 13472.26 crore in 2013-14, ₹ 16460.24 crore in 2014-15, ₹ 18684.12 crore in 2015-16, ₹ 21109.05 in 2016-17 and ₹ 21472.43 crore in 2017-18. Overall input output ratio is the lowest in the year 2013-14 with 1.0088 indicating that overall input has been optimally utilized in this year. It is the highest 1.1884 in 2011-12.

Overall Productivity Ratio: The highest overall productivity ratio is in the year 2013-14 with 0.9912 and the lowest in the year 2011-12 with 0.8415. Improvement in overall efficiency can also be observed from the average of overall indices which worked out to 105.28 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Tech Mahindra Ltd. is 5.81 with coefficient of variation 5.52%. Chi-square has been used for testing the hypothesis and its table value at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value is 1.455. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This decides that the overall productivity ratios of Tech Mahindra Ltd. for the eight years period are approximately the same and can be represented by straight line trend or line of best fit.

Table 7.12

Overall Productivity of Wipro Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	26949.60	30252.87	29664.36	32941.35	35024.33	39676.31	40209.89	37750.59
2	Material Input	3805.60	4300.74	2320.50	2079.58	2254.38	2221.82	1799.82	1174.21
3	Labour Input	10937.40	12286.51	13311.82	13991.51	14143.76	14516.82	14249.07	13793.43
4	Overhead Input	6428.30	7712.28	7311.19	7873.82	8632.23	10619.01	11158.75	10980.49
5	Total Input (Company Standard)	21171.30	24299.53	22943.51	23944.91	25030.37	27357.64	27207.64	25948.13
6	Normal Investor Input @ 38.48 % (Industry Standard)	8224.47	8815.26	7424.26	8818.90	10236.65	12689.51	14670.24	12666.31
7	Total Input (Industry Standard)	29395.77	33114.79	30367.77	32763.81	35267.02	40047.15	41877.88	38614.44
8	Overall Input Output Ratio (Industry Standard)	1.0908	1.0946	1.0237	0.9946	1.0069	1.0093	1.0415	1.0229
9	Overall Productivity Ratio (Industry Standard)	0.9168	0.9136	0.9768	1.0054	0.9931	0.9907	0.9602	0.9776
10	Overall Productivity Indices (Industry Standard) (O)	100.00	99.65	106.55	109.67	108.33	108.07	104.73	106.64
11	Computed Value /Expected Values (E)	102.33	103.22	104.11	105.01	105.90	106.79	107.69	108.58
12	Chi-Square $(O-E)^2/E$	0.0529	0.1234	0.0571	0.2069	0.0556	0.0152	0.0811	0.0348

Average Overall Productivity Indices = 105.45, a = 105.45, b = 0.45, χ^2 = 0.627, S.D. = 3.52, C.V. = 3.34 %.

Analysis and Interpretation

Output: The output of Wipro Ltd. lies between ₹ 26949.60 crore and ₹ 40209.89 crore. It is the lowest in the year 2010-11 while the highest in the year 2016-17.

Normal Investor Input: The normal investor input element of overall input of Wipro Ltd. is the maximum ₹ 14670.24 crore in 2016-17 and it is the minimum ₹ 7424.26 crore in 2012-13.

Total Input: Total input of Wipro Ltd. varies from ₹ 29395.77 crore to ₹ 41877.88 crore. Overall input output ratio is the lowest 0.9946 in 2013-14 indicates that overall input has been optimally utilized in the year 2013-14 as compared to the highest 1.0946 in 2011-12.

Overall Productivity Ratio: Overall productivity ratio is the highest 1.0054 in 2013-14 while it is the lowest 0.9136 in 2011-12. The highest overall productivity ratio is better as more amount of output is obtained with small amount of input. Overall efficiency can also be observed from the average of overall indices which worked out to 105.45 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Wipro Ltd. is 3.52 with 3.34% of variability. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Wipro Ltd. is 0.627. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This suggests that the overall productivity indices of the Wipro Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

7.3.4 Overall Productivity of Metals Sector Companies

Overall productivity of metals sector companies has been shown from table 7.13 to 7.16.

Table 7.13

Overall Productivity of Coal India Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	5473.42	8752.79	9829.37	13365.32	11696.91	14394.79	12656.19	7972.12
2	Material Input	10.03	8.89	9.97	10.09	13.60	8.64	6.77	5.54
3	Labour Input	251.11	285.24	290.24	270.87	262.84	257.56	270.99	332.88
4	Overhead Input	302.14	187.23	314.54	313.16	218.12	317.35	344.28	248.66
5	Total Input (Company Standard)	563.28	481.36	614.74	594.12	494.56	583.55	622.05	587.08
6	Normal Investor Input @ 15.86% (Industry Standard)	2921.21	2743.02	2593.55	1516.26	1689.36	1430.56	1357.71	1532.73
7	Total Input (Industry Standard)	3484.49	3224.38	3208.29	2110.38	2183.92	2014.11	1979.76	2119.81
8	Overall Input Output Ratio (Industry Standard)	0.6366	0.3684	0.3264	0.1579	0.1867	0.1399	0.1564	0.2659
9	Overall Productivity Ratio (Industry Standard)	1.5708	2.7146	3.0637	6.3331	5.3559	7.1470	6.3928	3.7608
10	Overall Productivity Indices (Industry Standard) (O)	100.00	172.81	195.04	403.18	340.97	454.99	406.98	239.42
11	Computed Value /Expected Values (E)	169.83	203.93	238.02	272.12	306.22	340.32	374.42	408.52
12	Chi-Square $(O-E)^2/E$	28.7093	4.7462	7.7613	63.1172	3.9420	38.6355	2.8305	69.9999

Average Overall Productivity Indices=289.17, a=289.17, b=17.05, χ^2 =219.742, S.D.=121.30, C.V. = 41.95%.

Analysis and Interpretation

Output: The output of Coal India Ltd. is depicting a fluctuating trend. It is the lowest ₹ 5473.42 crore in 2010-11 and it is the highest ₹ 14394.79 crore in 2015-16.

Normal Investor Input: It is ₹ 2921.21 crore in 2010-11 and reached to ₹ 1532.73 crore in 2017-18. It is the highest ₹ 2921.21 crore in 2010-11 while it is the lowest ₹ 1357.71 crore in 2016-17.

Total Input: Total input is ₹ 3484.49 crore in 2010-11 and after facing many fluctuations during the period of eight years reached to ₹ 2119.81 crore in 2017-18. Its input output ratio is the highest 0.6366 in 2010-11 while it is the lowest 0.1399 in 2015-16. The lowest overall input output ratio means overall input has been best utilized in the year 2015-16.

Overall Productivity Ratio: There is a fluctuating trend in the overall productivity ratio of Coal India Ltd. It is the lowest 1.5708 in 2010-11 while it is the highest 7.1470 in 2015-16. The higher ratio represents best utilisation of resources while the lower ratio indicates that the overall input has not been utilized efficiently. Improvement in overall efficiency can also be observed from the average of overall indices which worked out to 289.17 which is much higher than the base year index of 100.

Testing Hypothesis and Interpretation: In Coal India Ltd. the standard deviation calculated is 121.30 and coefficient of variation is 41.95% indicates variability. The computed value of chi-square is 219.742 while the table value of

chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This concludes that the overall productivity indices of the company for the study period are not same and cannot be represented by straight line trend or line of best fit.

Table 7.14

Overall Productivity of Hindalco Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	23812.03	24607.23	23337.28	23092.10	28592.89	29776.75	30320.65	34617.98
2	Material Input	16435.73	17035.37	15224.91	15747.71	17484.49	16652.83	18036.50	21013.57
3	Labour Input	1040.39	1027.62	1005.07	1027.07	1139.66	1152.98	1142.38	1201.21
4	Overhead Input	4310.55	4457.30	4704.89	5040.50	7137.03	10140.95	10436.14	10378.40
5	Total Input (Company Standard)	21786.67	22520.29	20934.87	21815.28	25761.18	27946.76	29615.02	32593.18
6	Normal Investor Input @ 15.86% (Industry Standard)	5650.16	6782.51	8320.28	8858.44	9114.87	9353.71	9750.91	9870.47
7	Total Input (Industry Standard)	27436.83	29302.80	29255.15	30673.72	34876.05	37300.47	39365.93	42463.65
8	Overall Input Output Ratio (Industry Standard)	1.1522	1.1908	1.2536	1.3283	1.2197	1.2527	1.2983	1.2266
9	Overall Productivity Ratio (Industry Standard)	0.8679	0.8398	0.7977	0.7528	0.8198	0.7983	0.7702	0.8152
10	Overall Productivity Indices (Industry Standard) (O)	100.00	96.76	91.91	86.74	94.46	91.98	88.75	93.93
11	Computed Value /Expected Values (E)	96.18	95.29	94.40	93.51	92.62	91.74	90.85	89.96
12	Chi-Square $(O-E)^2/E$	0.1520	0.0227	0.0654	0.4900	0.0366	0.0007	0.0486	0.1756

Average Overall Productivity Indices = 93.07, a = 93.07, b = -0.44, χ^2 = 0.991, S.D. = 3.96, C.V. = 4.26 %.

Analysis and Interpretation

Output: The revalued output of Hindalco Ltd. is ₹ 23812.03 crore in 2010-11 and reached to ₹ 34617.98 crore in 2017-18. It is the lowest ₹ 23092.10 crore in 2013-14 while it is the highest ₹ 34617.98 crore in 2017-18.

Normal Investor Input: It is the highest ₹ 9870.47 crore in 2017-18 and the lowest ₹ 5650.16 crore in 2010-11.

Total Input: Total input consumption of Hindalco Ltd. is ₹ 27436.83 crore in 2010-11, then it is increased and reached to ₹ 29302.80 crore in 2011-12, then it slightly decreased and reached to ₹ 29255.15 crore in 2012-13 then it continuously increased and ultimately reached to ₹ 42463.65 crore in 2017-18. Overall input output ratio is the lowest 1.1522 in 2010-11 while it is the highest 1.3283 in 2013-14.

Overall Productivity Ratio: Overall productivity ratio is the lowest 0.7528 in 2013-14 while it is the highest 0.8679 in 2010-11. The highest ratio indicates optimum exploitation of resources while the lowest ratio indicates under utilisation of resources as compared to other years. Overall efficiency can also be

observed from the average of overall indices which worked out to 93.07 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: Standard deviation of Hindalco Ltd. is 3.96 while its coefficient of variation is 4.26%. The computed value of chi-square is 0.991. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted. This presents that the overall productivity indices of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 7.15

Overall Productivity of Tata Steel Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	29751.06	31762.04	33240.61	34552.29	33571.38	35358.24	43080.57	49400.88
2	Material Input	7841.47	9104.15	10670.18	10315.52	11825.95	10978.64	13274.80	16644.20
3	Labour Input	2837.46	2812.62	3015.10	2802.56	3299.58	2936.61	3002.54	3061.49
4	Overhead Input	8554.97	10035.41	11536.30	12377.04	12806.26	13657.37	22201.02	18904.90
5	Total Input (Company Standard)	19233.90	21952.18	25221.58	25495.12	27931.79	27572.62	38478.37	38610.59
6	Normal Investor Input @ 15.86% (Industry Standard)	11581.45	11413.02	12039.52	12760.31	13741.50	14585.89	13525.19	14812.96
7	Total Input (Industry Standard)	30815.35	33365.20	37261.10	38255.43	41673.29	42158.51	52003.56	53423.55
8	Overall Input Output Ratio (Industry Standard)	1.0358	1.0505	1.1210	1.1072	1.2413	1.1923	1.2071	1.0814
9	Overall Productivity Ratio (Industry Standard)	0.9655	0.9520	0.8921	0.9032	0.8056	0.8387	0.8284	0.9247
10	Overall Productivity Indices (Industry Standard) (O)	100.00	98.60	92.40	93.55	83.44	86.87	85.81	95.78
11	Computed Value /Expected Values (E)	97.07	95.63	94.20	92.77	91.34	89.91	88.48	87.05
12	Chi-Square $(O-E)^2/E$	0.0887	0.0920	0.0345	0.0065	0.6832	0.1027	0.0807	0.8760

Average Overall Productivity Indices = 92.06, a = 92.06, b = -0.72, χ^2 = 1.964, S.D. = 5.73, C.V. = 6.22 %.

Analysis and Interpretation

Output: The output of Tata Steel Ltd. is ₹ 29751.06 crore in 2010-11, then increased and reached to ₹ 34552.29 crore in 2013-14 then it decreased in the year 2014-15 and ultimately it increased and reached to ₹ 49400.88 crore in 2017-18.

Normal Investor Input: It is ₹ 11581.45 crore in 2010-11, ₹ 11413.02 crore in 2011-12, ₹ 12039.52 crore in 2012-13, ₹ 12760.31 crore in 2013-14, ₹ 13741.50 crore in 2014-15, ₹ 14585.89 crore in 2015-16, ₹ 13525.19 crore in 2016-17 and lastly ₹ 14812.96 crore in 2017-18.

Total Input: Total input of Tata Steel Ltd. ranges between ₹ 30815.35 crore to ₹ 53423.55 crore. It is the lowest in 2010-11 and the highest in 2017-18. Overall input output ratio is the lowest 1.0358 in 2010-11 and the highest 1.2413 in 2014-

15. The lowest overall input output ratio means overall input of Tata Steel Ltd. has been optimally utilized in the year 2010-11.

Overall Productivity Ratio: Overall productivity ratio of Tata Steel Ltd. is the lowest 0.8056 in 2014-15 and the highest 0.9655 in 2010-11. Improvement in overall efficiency can also be observed from the average of overall indices which is 92.06 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Tata Steel Ltd. is 5.73 with 6.22 % of variability. The computed value of chi-square is 1.964 as compared to the table value 14.067 at 5% level of significance with (8-1) = 7 degree of freedom. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted. This indicates that the overall productivity indices of the Tata Steel Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 7.16

Overall Productivity of Vedanta Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	7996.15	6378.58	2133.63	24314.13	28028.71	32447.13	37817.67	39453.82
2	Material Input	1178.32	1119.23	421.19	15610.12	16485.76	15694.80	16529.96	20897.85
3	Labour Input	149.08	176.70	154.53	426.58	466.14	409.80	511.17	508.47
4	Overhead Input	2221.06	2332.07	1445.55	7053.78	6295.44	7362.21	10919.79	12479.23
5	Total Input (Company Standard)	3548.46	3627.99	2021.27	23090.48	23247.34	23466.80	27960.91	33885.54
6	Normal Investor Input @ 15.86% (Industry Standard)	1742.28	1954.54	1971.61	8162.39	8256.43	9863.86	14949.57	13669.33
7	Total Input (Industry Standard)	5290.74	5582.53	3992.88	31252.87	31503.77	33330.66	42910.48	47554.87
8	Overall Input Output Ratio (Industry Standard)	0.6617	0.8752	1.8714	1.2854	1.1240	1.0272	1.1347	1.2053
9	Overall Productivity Ratio (Industry Standard)	1.5113	1.1426	0.5344	0.7780	0.8897	0.9735	0.8813	0.8296
10	Overall Productivity Indices (Industry Standard) (O)	100.00	75.60	35.36	51.48	58.87	64.41	58.31	54.89
11	Computed Value /Expected Values (E)	75.18	71.52	67.86	64.20	60.53	56.87	53.21	49.55
12	Chi-Square $(O-E)^2/E$	8.1921	0.2328	15.5674	2.5205	0.0459	0.9997	0.4895	0.5770

Average Overall Productivity Indices= 62.37, a = 62.37, b = -1.83, χ^2 = 28.625, S.D. = 17.78, C.V. = 28.51%.

Analysis and Interpretation

Output: The output of Vedanta Ltd. is the highest ₹ 39453.82 crore in 2017-18 while it is the lowest ₹ 2133.63 crore in 2012-13.

Normal Investor Input: Normal investor input at 15.86% industry standard rate is the highest ₹ 14949.57 crore in 2016-17 and the lowest ₹ 1742.28 crore in 2010-11.

Total Input: Total input consumption of Vedanta Ltd. is presenting an increasing trend except in the year 2012-13. It is ₹ 5290.74 crore in 2010-11 then reached to

₹ 47554.87 crore in 2017-18. Overall input output ratio is the highest 1.8714 in 2012-13 while it is the lowest 0.6617 in 2010-11.

Overall Productivity Ratio: Overall productivity ratio of Vedanta Ltd. is 1.5113 in 2010-11 and reached to 0.8296 in 2017-18. Overall productivity ratio is the lowest 0.5344 in 2012-13 while it is the highest 1.5113 in 2010-11. Overall efficiency can also be analysed from the average of overall indices. It is 62.37, which is lower than the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Vedanta Ltd. is 17.78 with coefficient of variation 28.51%. The computed value of chi-square is 28.625. The table value of chi-square at 5% level of significance with (8-1) = 7 d.f. is 14.067. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This presents that the overall productivity indices of the Vedanta Ltd. for the study period are not same.

7.3.5 Overall Productivity of Pharmaceutical Sector Companies

Overall productivity of pharmaceutical sector companies has been shown from table 7.17 to 7.20

Table 7.17

Overall Productivity of Cipla Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	6308.14	6551.80	6992.95	7754.00	8004.10	10480.54	9185.26	9242.54
2	Material Input	3085.90	2706.24	2955.09	3266.28	3557.98	4003.52	3439.46	3585.25
3	Labour Input	464.20	672.14	811.29	980.26	1079.50	1215.17	1127.29	1132.29
4	Overhead Input	1852.99	1841.76	1982.17	2159.08	2530.24	3138.51	3394.14	3110.92
5	Total Input (Company Standard)	5403.09	5220.14	5748.55	6405.62	7167.72	8357.20	7960.88	7828.46
6	Normal Investor Input @ 18.85% (Industry Standard)	1200.58	1306.64	1472.46	1644.71	1821.17	2066.14	2108.97	2233.90
7	Total Input (Industry Standard)	6603.67	6526.78	7221.01	8050.33	8988.89	10423.34	10069.85	10062.36
8	Overall Input Output Ratio (Industry Standard)	1.0468	0.9962	1.0326	1.0382	1.1230	0.9945	1.0963	1.0887
9	Overall Productivity Ratio (Industry Standard)	0.9552	1.0038	0.9684	0.9632	0.8904	1.0055	0.9122	0.9185
10	Overall Productivity Indices (Industry Standard) (O)	100.00	105.09	101.38	100.83	93.22	105.26	95.49	96.16
11	Computed Value /Expected Values (E)	102.63	101.79	100.94	100.10	99.26	98.41	97.57	96.72
12	Chi-Square $(O-E)^2/E$	0.0674	0.1070	0.0019	0.0054	0.3675	0.4765	0.0443	0.0033

Average Overall Productivity Indices = 99.68, a = 99.68, b = - 0.42, χ^2 = 1.073, S.D. = 4.13, C.V. = 4.14 %.

Analysis and Interpretation

Output: The output of Cipla Ltd. is showing an increasing trend except in the year 2016-17.

Normal Investor Input: It is showing an increasing trend. It lies between ₹ 1200.58 crore in 2010-11 and ₹ 2233.90 crore in 2017-18. It is calculated on the basis of 18.85% of the average investment.

Total Input: Total input ranges from ₹ 6526.78 crore to ₹ 10423.34 crore. Its input output ratio lies between 0.9945 and 1.1230. The lowest overall input output ratio in the year 2015-16 means total input has been best utilised in this year.

Overall Productivity Ratio: There is an erratic trend in the overall productivity ratios of Cipla Ltd. It is 0.9552 in 2010-11, 1.0038 in 2011-12, 0.9684 in 2012-13, 0.9632 in 2013-14, 0.8904 in 2014-15, 1.0055 in 2015-16, 0.9122 in 2016-17 and 0.9185 in 2017-18. Overall productivity ratio is the lowest 0.8904 in 2014-15 while it is the highest 1.0055 in 2015-16. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overall inputs have not been utilised efficiently and mismanagement may be responsible for the low productivity. Improvement in overall efficiency can also be observed from the average of overall indices which worked out to 99.68 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation is 4.13 with 4.14% of variability of Cipla Ltd. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Cipla Ltd. is 1.073. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted. This reveals that the overall productivity indices of the Cipla Ltd. for the study period are approximately same and can be represented by straight line trend.

Table 7.18

Overall Productivity of Dr. Reddy's Laboratories Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	5345.10	6165.93	7280.11	7922.46	8225.15	8724.64	8487.52	7599.85
2	Material Input	1749.50	1948.82	2381.06	2248.41	2538.90	2534.44	2494.10	2549.29
3	Labour Input	701.20	799.41	952.59	904.08	1068.98	1161.09	1175.75	1168.46
4	Overhead Input	1995.20	2417.70	2568.31	2975.76	2917.24	3586.31	3375.57	3251.19
5	Total Input (Company Standard)	4445.90	5165.93	5901.96	6128.25	6525.12	7281.83	7045.42	6968.94
6	Normal Investor Input @ 18.85% (Industry Standard)	1171.15	1219.38	1254.01	1565.40	1798.46	2061.16	1963.19	2026.25
7	Total Input (Industry Standard)	5617.05	6385.31	7155.97	7693.65	8323.58	9342.99	9008.61	8995.19
8	Overall Input Output Ratio (Industry Standard)	1.0509	1.0356	0.9829	0.9711	1.0120	1.0709	1.0614	1.1836
9	Overall Productivity Ratio (Industry Standard)	0.9516	0.9656	1.0173	1.0297	0.9882	0.9338	0.9422	0.8449
10	Overall Productivity Indices (Industry Standard) (O)	100.00	101.48	106.91	108.21	103.85	98.13	99.01	88.79
11	Computed Value /Expected Values (E)	105.86	104.41	102.97	101.52	100.07	98.63	97.18	95.73
12	Chi-Square $(O-E)^2/E$	0.3245	0.0826	0.1510	0.4412	0.1422	0.0025	0.0344	0.5040

Average Overall Productivity Indices= 100.80, a = 100.80, b = - 0.72, χ^2 = 1.682, S.D. = 5.67, C.V. = 5.63 %.

Analysis and Interpretation

Output: The output of Dr. Reddy's Laboratories Ltd. is ₹ 5345.10 crore in 2010-11, ₹ 6165.93 crore in 2011-12, ₹ 7280.11 crore in 2012-13, ₹ 7922.46 crore in for 2013-14, ₹ 8225.15 crore in 2014-15, ₹ 8724.64 crore in 2015-16, for 2016-17 output is ₹ 8487.52 crore and for 2017-18 it is ₹ 7599.85 crore.

Normal Investor Input: The normal investor input of Dr. Reddy's Laboratories Ltd. is ₹ 1171.15 crore, ₹ 1219.38 crore, ₹ 1254.01 crore, ₹ 1565.40 crore, ₹ 1798.46 crore, ₹ 2061.16 crore, ₹ 1963.19 crore and ₹ 2026.25 crore from 2010-11 to 2017-18 respectively.

Total Input: Total input is the minimum ₹ 5617.05 crore in the year 2010-11 as compared to the maximum ₹ 9342.99 crore in 2015-16. Its input output ratio is the maximum 1.1836 in 2017-18 as compared to the minimum 0.9711 in 2013-14.

Overall Productivity Ratio: Overall productivity ratio is changeable in nature. It is the lowest 0.8449 in 2017-18 while it is the highest 1.0297 in 2013-14. The highest ratio displays efficiency and effectiveness while the lowest ratio conveys that the overall inputs have not been utilized efficiently. Improvement in overall efficiency can also be observed from the average of overall indices which is 100.80 as compared to the base year.

Testing Hypothesis and Interpretation: The standard deviation of Dr. Reddy's Laboratories Ltd. is 5.67 with 5.63% of variability. For testing the hypothesis chi-square method has been used. The table value of chi-square at 5% level of

significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Dr. Reddy's Laboratories Ltd. is 1.682. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This reveals that the overall productivity ratios of the Dr. Reddy's Laboratories Ltd. for the eight year period are approximately the same and can be represented by straight line trend or line of best fit.

Table 7.19

Overall Productivity of Lupin Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	4510.95	4824.82	5981.54	7571.30	7868.41	9452.23	10416.18	8232.87
2	Material Input	1921.18	2182.49	2512.11	2630.34	2830.58	3231.78	3289.47	3022.57
3	Labour Input	491.23	536.47	596.85	644.22	754.68	808.46	914.78	914.00
4	Overhead Input	1228.24	1403.97	1670.17	1812.80	1940.20	2343.51	2943.02	2595.72
5	Total Input (Company Standard)	3640.65	4122.93	4779.13	5087.36	5525.46	6383.75	7147.27	6532.29
6	Normal Investor Input @ 18.85% (Industry Standard)	605.45	675.79	798.00	1034.75	1330.45	1744.83	2243.76	2531.39
7	Total Input (Industry Standard)	4246.10	4798.72	5577.13	6122.11	6855.91	8128.58	9391.03	9063.68
8	Overall Input Output Ratio (Industry Standard)	0.9413	0.9946	0.9324	0.8086	0.8713	0.8600	0.9016	1.1009
9	Overall Productivity Ratio (Industry Standard)	1.0624	1.0054	1.0725	1.2367	1.1477	1.1628	1.1092	0.9083
10	Overall Productivity Indices (Industry Standard) (O)	100.00	94.64	100.95	116.41	108.03	109.46	104.40	85.50
11	Computed Value /Expected Values (E)	103.91	103.48	103.06	102.64	102.21	101.79	101.37	100.94
12	Chi-Square $(O-E)^2/E$	0.1468	0.7555	0.0430	1.8485	0.3311	0.5775	0.0910	2.3625

Average Overall Productivity Indices = 102.42, a = 102.42, b = - 0.21, χ^2 = 6.156, S.D. = 8.91, C.V. = 8.70%.

Analysis and Interpretation

Output: The output of Lupin Ltd. is ₹ 4510.95 crore for the year 2010-11 and it reached to ₹ 8232.87 crore in 2017-18.

Normal Investor Input: The normal investor input element of the total input of Lupin Ltd. lies between ₹ 605.45 crore in 2010-11 and ₹ 2531.39 crore in 2017-18.

Total Input: The total input of Lupin Ltd. is showing an upward trend except in the year 2017-18. It is ₹ 4246.10 crore in 2010-11 and reached to ₹ 9063.68 crore in 2017-18. Its input output ratio is the lowest 0.8086 in the year 2013-14 indicating that overall inputs have been optimally utilized in this year. It is the highest 1.1009 in 2017-18.

Overall Productivity Ratio: Overall productivity ratio is presenting an erratic trend. It is 1.0624 in 2010-11, 1.0054 in 2011-12, 1.0725 in 2012-13, 1.2367 in 2013-14, 1.1477 in 2014-15, 1.1628 in 2015-16, 1.1092 in 2016-17, 0.9083 in 2017-18. The highest overall productivity ratio in 2013-14 with 1.2367 conveys

that overall inputs have been best utilized in 2013-14. Improvement in overall efficiency can also be observed from the average of overall indices which worked out as 102.42 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Lupin Ltd. is 8.91 with coefficient of variation 8.70%. Chi-square has been used for testing the hypothesis and its table value at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Lupin Ltd. is 6.156. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and the alternative hypothesis is rejected. This depicts that the overall productivity ratios of the Lupin Ltd. for the eight year period are approximately the same and can be represented by straight line trend or line of best fit.

Table 7.20

Overall Productivity of Sun Pharmaceutical Industries Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	3300.23	3925.99	2283.03	2426.49	6888.78	6677.42	6699.57	7378.69
2	Material Input	928.85	1154.65	925.89	1031.91	2853.90	2971.54	3204.99	3039.36
3	Labour Input	214.06	292.18	196.59	213.36	1065.95	1005.27	977.92	1025.62
4	Overhead Input	699.95	774.62	612.30	1142.17	3267.67	3113.52	2508.79	2278.34
5	Total Input (Company Standard)	1842.86	2221.45	1734.78	2387.43	7187.52	7090.33	6691.71	6343.32
6	Normal Investor Input @ 18.85% (Industry Standard)	1155.13	1275.93	1307.79	1836.45	4278.33	4217.66	3726.87	3508.47
7	Total Input (Industry Standard)	2997.99	3497.38	3042.57	4223.88	11465.85	11307.99	10418.58	9851.79
8	Overall Input Output Ratio (Industry Standard)	0.9084	0.8908	1.3327	1.7407	1.6644	1.6935	1.5551	1.3352
9	Overall Productivity Ratio (Industry Standard)	1.1008	1.1226	0.7504	0.5745	0.6008	0.5905	0.6430	0.7490
10	Overall Productivity Indices (Industry Standard) (O)	100.00	101.97	68.16	52.19	54.58	53.64	58.41	68.04
11	Computed Value /Expected Values (E)	89.74	83.99	78.24	72.50	66.75	61.01	55.26	49.51
12	Chi-Square $(O-E)^2/E$	1.1736	3.8505	1.2986	5.6910	2.2199	0.8886	0.1803	6.9317

Average Overall Productivity Indices= 69.62, a= 69.62, b = - 2.87, χ^2 = 22.234, S.D. = 18.99, C.V. = 27.28%.

Analysis and Interpretation

Output: The output of Sun Pharmaceutical Industries Ltd. showing a fluctuating trend. Output in 2010-11 is ₹ 3300.23 crore, in 2011-12 ₹ 3925.99 crore, in 2012-13 ₹ 2283.03 crore, in 2013-14 ₹ 2426.49 crore, in 2014-15 ₹ 6888.78 crore, in 2015-16 ₹ 6677.42 crore, in 2016-17 ₹ 6699.57 crore, in 2017-18 ₹ 7378.69 crore.

Normal Investor Input: The calculated normal investor input of Sun Pharmaceutical Industries Ltd. is depicting an increasing trend till 2014-15 then after that it is decreasing. It is the lowest ₹ 1155.13 crore in 2010-11 while it is the highest ₹ 4278.33 crore in the year 2014-15.

Total Input: Total input of Sun Pharmaceutical Industries Ltd. is highlighting an inconsistent trend. It is ₹ 2997.99 crore in 2010-11 and reached ₹ 9851.79 crore in 2017-18. Overall input output ratio is the highest 1.7407 in 2013-14 while it is the lowest 0.8908 in 2011-12. The lowest ratio reflects that overall input has been optimally utilized in the year 2011-12.

Overall Productivity Ratio: It is the highest 1.1226 in 2011-12 while it is the lowest 0.5745 in 2013-14. Overall efficiency can also be observed from the average of overall indices which worked out to 69.62 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Sun Pharmaceutical Industries Ltd. is 18.99 with 27.28% of variability. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067 while the calculated value of chi-square of Sun Pharmaceutical Industries Ltd. is 22.234. As the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected and the alternative hypothesis is accepted. This decides that the overall productivity indices of the Sun Pharmaceutical Industries Ltd. for the study period are not same and cannot be represented by straight line trend or line of best fit.

7.3.6. Overall Productivity of Refineries Sector Companies

Overall productivity of refineries sector companies has been shown from table 7.21 to 7.24.

Table 7.21

Overall Productivity of Bharat Petroleum Corporation Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	151243.98	195601.15	206438.48	211751.09	197308.95	160737.40	163969.29	191476.02
2	Material Input	141028.03	181705.99	192015.96	196106.00	170667.32	135606.24	149882.95	165479.84
3	Labour Input	2802.85	2086.97	2317.54	2209.92	1495.38	1954.87	2236.01	2175.24
4	Overhead Input	8011.77	9668.26	9773.44	10984.12	11742.01	12701.29	11537.10	13910.31
5	Total Input (Company Standard)	151842.65	193461.22	204106.94	209300.03	183904.71	150262.40	163656.06	181565.39
6	Normal Investor Input @ 5.55% (Industry Standard)	983.16	1012.24	1276.07	1666.60	1846.75	2211.30	2454.72	2811.05
7	Total Input (Industry Standard)	152825.81	194473.46	205383.01	210966.63	185751.46	152473.70	166110.78	184376.44
8	Overall Input Output Ratio (Industry Standard)	1.0105	0.9942	0.9949	0.9963	0.9414	0.9486	1.0131	0.9629
9	Overall Productivity Ratio (Industry Standard)	0.9896	1.0058	1.0051	1.0037	1.0622	1.0542	0.9871	1.0385
10	Overall Productivity Indices (Industry Standard) (O)	100.00	101.63	101.57	101.42	107.33	106.52	99.74	104.94
11	Computed Value /Expected Values (E)	100.98	101.53	102.07	102.62	103.17	103.71	104.26	104.81
12	Chi-Square $(O-E)^2/E$	0.0095	0.0001	0.0025	0.0140	0.1682	0.0761	0.1957	0.0002

Average Overall Productivity Indices = 102.89, a = 102.89, b = 0.27, χ^2 = 0.466, S.D. = 2.76, C.V. = 2.68 %.

Analysis and Interpretation

Output: The output of Bharat Petroleum Corporation Ltd. is conveys a fluctuating trend. It is the highest ₹ 211751.09 crore in 2013-14 and it is the lowest ₹ 151243.98 crore in 2010-11.

Normal Investor Input: It is having an increasing trend with the lowest ₹ 983.16 crore in 2010-11 and the highest reached to ₹ 3508.47 crore in 2017-18.

Total Input: Total input is ₹ 152825.81 crore in 2010-11 and reached to ₹ 184376.44 crore in 2017-18. Its input output ratio is the highest 1.0131 in 2016-17 while it is the lowest 0.9414 in 2014-15. The lowest overall input output ratio means overall input has been best utilized in the year 2014-15.

Overall Productivity Ratio: There is no trend in the overall productivity ratios of Bharat Petroleum Corporation Ltd. Overall productivity ratio is the lowest 0.9871 in 2016-17 while it is the highest 1.0622 in 2014-15. Improvement in overall efficiency can also be observed from the average of overall indices which worked out to 102.89 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: In Bharat Petroleum Corporation Ltd. the standard deviation calculated is 2.76 and coefficient of variation is 2.68% indicates less variability. The computed value of chi-square is 0.466 while the table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted. This reveals that the overall productivity indices of the company for the study period are approximately equal and can be represented by straight line trend or line of best fit.

Table 7.22

Overall Productivity of Hindustan Petroleum Corporation Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	131403.70	163897.08	179216.63	182515.82	170937.91	151402.12	151501.59	177367.29
2	Material Input	126018.95	152954.44	164658.33	169304.86	149845.39	131401.22	138400.31	154915.22
3	Labour Input	1981.84	1461.20	2113.89	1549.12	1731.31	1571.57	1920.84	1812.30
4	Overhead Input	7035.44	8038.91	8869.66	9618.92	9573.47	12897.69	10618.35	11680.94
5	Total Input (Company Standard)	135036.23	162454.56	175641.88	180472.90	161150.17	145870.48	150939.50	168408.46
6	Normal Investor Input @ 5.55% (Industry Standard)	1402.86	1539.20	1767.77	2186.55	2250.72	2259.00	1725.08	2075.60
7	Total Input (Industry Standard)	136439.09	163993.76	177409.65	182659.45	163400.89	148129.48	152664.58	170484.06
8	Overall Input Output Ratio (Industry Standard)	1.0383	1.0006	0.9899	1.0008	0.9559	0.9784	1.0077	0.9612
9	Overall Productivity Ratio (Industry Standard)	0.9631	0.9994	1.0102	0.9992	1.0461	1.0221	0.9924	1.0404
10	Overall Productivity Indices (Industry Standard) (O)	100.00	103.77	104.89	103.75	108.62	106.13	103.04	108.02
11	Computed Value /Expected Values (E)	102.23	102.96	103.69	104.41	105.14	105.87	106.60	107.32
12	Chi-Square $(O-E)^2/E$	0.0487	0.0064	0.0140	0.0042	0.1152	0.0006	0.1186	0.0046

Average Overall Productivity Indices = 104.78, a = 104.78, b = 0.36, χ^2 = 0.312, S.D. = 2.62, C.V. = 2.50 %.

Analysis and Interpretation

Output: The output of Hindustan Petroleum Corporation Ltd. is ₹ 131403.70 crore in 2010-11 and reached to ₹ 177367.29 crore in 2017-18.

Normal Investor Input: It is the highest ₹ 2259.00 crore in 2015-16 and the lowest ₹ 1402.86 crore in 2010-11.

Total Input: Total input consumption is ₹ 136439.09 crore in 2010-11 then it is increased and reached to ₹ 182659.45 crore in 2013-14, then it decreased and reached to ₹ 148129.48 crore in 2015-16, again increased and ultimately reached to ₹ 170484.06 crore in 2017-18. Overall input output ratio is the highest 1.0383 in 2010-11 while it is the lowest 0.9559 in 2014-15.

Overall Productivity Ratio: Overall productivity ratio of Hindustan Petroleum Corporation Ltd. is the lowest 0.9631 in 2010-11 while it is the highest 1.0461 in 2014-15. The higher ratio depicts that resources have been utilised efficiently while the lower ratio indicates that the overall inputs have not been properly utilized. Overall efficiency can also be observed from the average of overall indices which worked out as 104.78 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: Standard deviation of Hindustan Petroleum Corporation Ltd. is 2.62 while its coefficient of variation is 2.50%. The computed value of chi-square is 0.312 and its table value at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted

and alternative hypothesis is rejected. This reveals that the overall productivity indices of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 7.23

Overall Productivity of Indian Oil Corporation Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	326553.94	399196.39	382590.88	387987.09	362608.32	298354.22	287130.68	343394.88
2	Material Input	299785.74	362045.91	351690.29	346722.95	310163.65	240795.91	247461.57	273895.48
3	Labour Input	6435.55	4596.60	6086.05	5050.27	5094.13	5185.58	6336.74	6390.35
4	Overhead Input	18436.42	22663.97	23768.90	27586.42	26532.94	32126.51	34148.43	31044.81
5	Total Input (Company Standard)	324657.71	389306.47	381545.24	379359.63	341790.72	278108.00	287946.73	311330.64
6	Normal Investor Input @ 5.55% (Industry Standard)	4147.71	4337.25	5321.29	6132.80	6573.33	6735.49	6707.98	7381.33
7	Total Input (Industry Standard)	328805.42	393643.72	386866.53	385492.43	348364.05	284843.49	294654.71	318711.97
8	Overall Input Output Ratio (Industry Standard)	1.0069	0.9861	1.0112	0.9936	0.9607	0.9547	1.0262	0.9281
9	Overall Productivity Ratio (Industry Standard)	0.9932	1.0141	0.9889	1.0065	1.0409	1.0474	0.9745	1.0774
10	Overall Productivity Indices (Industry Standard) (O)	100.00	102.11	99.58	101.34	104.81	105.47	98.12	108.49
11	Computed Value /Expected Values (E)	99.96	100.68	101.41	102.13	102.85	103.57	104.29	105.01
12	Chi-Square $(O-E)^2/E$	0.0000	0.0202	0.0330	0.0061	0.0373	0.0347	0.3654	0.1150

Average Overall Productivity Indices = 102.49, a = 102.49, b = 0.36, χ^2 = 0.612, S.D. = 3.27, C.V. = 3.19 %.

Analysis and Interpretation

Output: The output of Indian Oil Corporation Ltd. is changeful in nature. It is ₹ 326553.94 crore in 2010-11 and reached to ₹ 343394.88 crore in 2017-18.

Normal Investor Input: Normal investor input is showing an increasing trend except in the year 2016-17. It is the lowest ₹ 4147.71 crore in 2010-11 while it is the highest ₹ 7381.33 crore in 2017-18.

Total Input: Total input of Indian Oil Corporation Ltd. is ₹ 328805.42 crore in 2010-11 and reached to ₹ 318711.97 crore in 2017-18. Overall input output ratio is the highest 1.0262 in 2016-17 while it is the lowest 0.9281 in 2010-11. The lowest overall input output ratio means overall inputs have been utilized best in the year 2010-11.

Overall Productivity Ratio: Overall productivity ratio of Indian Oil Corporation Ltd. is the lowest 0.9745 in 2016-17 while it is the highest 1.0774 in 2017-18. The higher the ratio indicates that all inputs have been utilised efficiently while the lower the ratio indicates that the overall inputs have not been utilized perfectly. Improvement in overall efficiency can also be observed from the average of overall indices which is 102.49 as compared to the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Indian Oil Corporation Ltd. is 3.27 with 3.19% of variability. The computed value of chi-square is 0.612 as compared to the table value 14.067 at 5% level of significance with (8-1) = 7 degree of freedom. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This reflects that the overall productivity indices of the Indian Oil Corporation Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 7.24

Overall Productivity of Reliance Industries Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	247978.66	307735.63	313516.10	325963.44	273830.44	204990.51	202371.59	235728.97
2	Material Input	198076.21	256798.57	266657.65	272774.93	215874.20	135405.68	143569.06	168327.73
3	Labour Input	2624.17	2641.63	2807.30	2571.31	2642.86	2892.54	2890.97	3005.16
4	Overhead Input	26194.52	24594.48	25538.02	25550.00	27951.56	30384.11	30785.24	32376.11
5	Total Input (Company Standard)	226894.90	284034.68	295002.97	300896.24	246468.62	168682.32	177245.27	203709.00
6	Normal Investor Input @ 5.55% (Industry Standard)	12229.74	11569.65	11722.01	13364.56	15250.94	16973.86	20097.67	21536.07
7	Total Input (Industry Standard)	239124.64	295604.33	306724.98	314260.80	261719.56	185656.18	197342.94	225245.07
8	Overall Input Output Ratio (Industry Standard)	0.9643	0.9606	0.9783	0.9641	0.9558	0.9057	0.9752	0.9555
9	Overall Productivity Ratio (Industry Standard)	1.0370	1.0410	1.0221	1.0372	1.0463	1.1041	1.0255	1.0465
10	Overall Productivity Indices (Industry Standard) (O)	100.00	100.39	98.56	100.02	100.89	106.47	98.89	100.92
11	Computed Value /Expected Values (E)	99.79	100.07	100.35	100.63	100.91	101.19	101.47	101.75
12	Chi-Square $(O-E)^2/E$	0.0005	0.0010	0.0317	0.0037	0.0000	0.2760	0.0656	0.0068

Average Overall Productivity Indices = 100.77, a = 100.77, b = 0.14, χ^2 = 0.385, S.D. = 2.30, C.V. = 2.28%.

Analysis and Interpretation

Output: The output of Reliance Industries Ltd. is the highest ₹ 325963.44 crore in 2013-14 while it is the lowest ₹ 202371.59 crore in 2016-17.

Normal Investor Input: It is the highest ₹ 21536.07 crore in 2017-18 and the lowest ₹ 11569.65 crore in 2011-12.

Total Input: Total input consumption of Reliance Industries Ltd. is ₹ 239124.64 crore in 2010-11 and reached to ₹ 225245.07 crore in 2017-18. Overall input output ratio is the highest 0.9783 in 2012-13 while it is the lowest 0.9057 in 2015-16.

Overall Productivity Ratio: Overall productivity ratio is the lowest 1.0221 in 2012-13 while it is the highest 1.1041 in 2015-16. The higher ratio depicts efficiency in utilisation of its inputs while the lower ratio demonstrates underutilisation of resources. Overall efficiency can also be analysed from the

average of overall indices. It is 100.77 which are slight higher than the base year index of 100.

Testing Hypothesis and Interpretation: The standard deviation of Reliance Industries Ltd. is 2.30 with coefficient of variation 2.28%. The computed value of chi-square of is 0.385. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted and alternative hypothesis is rejected. This concludes that the overall productivity indices of the Reliance Industries Ltd. for the study period are not same and cannot be represented by straight line trend or line of best fit.

7.4. Overall Productivity Ratios and Kruskal Wallis One Way Analysis of Variance Test

To analyse the inter-company relationship, second hypothesis has been developed and tested with the help of kruskal wallis one way analysis of variance test. For this reason, the overall productivity of all the sample companies of a particular sector is combined, arranged and given a rank number. The rank sum of each of the sample has been calculated. The detailed calculation has been done in the tables below from table 7.25 to 7.30.

Table 7.25

Comparative Overall Productivity Ratios from 2010-11 to 2017-18 of Automobile Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	Bajaj Auto Ltd.		Mahindra & Mahindra Ltd.		Maruti Suzuki India Ltd.		Tata Motors Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	1.1922	32	1.0280	23	1.0108	19	0.9260	8
2011-12	1.1743	31	0.9794	15	0.9665	9	0.9181	6
2012-13	1.1613	29	1.0163	21	0.9752	14	0.8984	5
2013-14	1.1585	28	0.9899	17	0.9729	12	0.8709	3
2014-15	1.1177	27	0.9978	18	0.9718	11	0.7647	1
2015-16	1.1658	30	0.9746	13	1.0123	20	0.8875	4
2016-17	1.1048	26	0.9695	10	1.0245	22	0.8174	2
2017-18	1.0979	25	0.9897	16	1.0315	24	0.9248	7
Total		228		133		131		36

H = 26.185

Hypothesis Testing and Interpretation: At 5% level of significance with (4-1) = 3 d. f., the table value is 7.815. The calculated value of H is 26.185. As the calculated value is greater than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that the overall productivity ratios of the selected automobile sector companies included in Nifty 50 are not same and there is difference in the overall productivity ratios.

Table 7.26

Comparative Overall Productivity Ratios from 2010-11 to 2017-18 of Energy Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	GAIL (India) Ltd.		NTPC Ltd.		Oil and Natural Gas Corporation Ltd.		Power Grid Corporation of India Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	1.0522	30	0.9147	20	1.1344	32	0.6552	8
2011-12	0.9945	27	0.9052	19	1.1288	31	0.6085	7
2012-13	0.9989	28	0.9037	18	1.0145	29	0.5824	4
2013-14	0.9649	24	0.8595	15	0.9756	26	0.5290	2
2014-15	0.9518	23	0.8015	12	0.8891	16	0.5085	1
2015-16	0.9399	21	0.7785	10	0.8949	17	0.5541	3
2016-17	0.9514	22	0.7869	11	0.8514	13	0.5956	5
2017-18	0.9650	25	0.7622	9	0.8536	14	0.5993	6
Total		200		114		178		36

H = 23.125

Testing Hypothesis and Interpretation: The calculated value of H is 23.125 and the table value is 7.815 at 5% level of significance with (4-1) = 3 degrees of freedom. As the calculated value is more than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that there is a significant difference in overall productivity of the energy sector companies included in Nifty 50.

Table 7.27

Comparative Overall Productivity Ratios from 2010-11 to 2017-18 of Information Technology Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	Infosys Ltd.		Tata Consultancy Services Ltd.		Tech Mahindra Ltd.		Wipro Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	1.0240	20	1.0927	25	0.8792	3	0.9168	5
2011-12	1.0497	21	1.1494	27	0.8415	1	0.9136	4
2012-13	1.0120	17	1.1158	26	0.8766	2	0.9768	10
2013-14	1.0181	18	1.1746	30	0.9912	14	1.0054	16
2014-15	1.0537	22	1.1739	29	0.9444	7	0.9931	15
2015-16	1.0683	23	1.1990	32	0.9890	12	0.9907	13
2016-17	1.0204	19	1.1540	28	0.9380	6	0.9602	9
2017-18	1.0712	24	1.1887	31	0.9448	8	0.9776	11
Total		164		228		53		83

H = 26.821

Testing Hypothesis and Interpretation: The calculated value of H is 26.821 and the table value is 7.815 at 5% level of significance with (4-1) = 3 degrees of freedom. As the calculated value is more than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that there is a significant difference in the overall productivity ratios of the information technology sector companies included in Nifty 50.

Table 7.28

Comparative Overall Productivity Ratios from 2010-11 to 2017-18 of Metals Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	Coal India Ltd.		Hindalco Ltd.		Tata Steel Ltd.		Vedanta Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	1.5708	25	0.8679	14	0.9655	21	1.5113	24
2011-12	2.7146	26	0.8398	13	0.9520	20	1.1426	23
2012-13	3.0637	27	0.7977	5	0.8921	17	0.5344	1
2013-14	6.3331	30	0.7528	2	0.9032	18	0.7780	4
2014-15	5.3559	29	0.8198	9	0.8056	7	0.8897	16
2015-16	7.1470	32	0.7983	6	0.8387	12	0.9735	22
2016-17	6.3928	31	0.7702	3	0.8284	10	0.8813	15
2017-18	3.7608	28	0.8152	8	0.9247	19	0.8296	11
Total		228		60		124		116

H = 20.909

Testing Hypothesis and Interpretation: The calculated value of H is 20.909 and the table value is 7.815 at 5% level of significance with (4-1) = 3 degrees of freedom. As the calculated value is more than the table value hence null hypothesis is rejected. This means that the overall productivity ratios of the metals sector companies included in Nifty 50 are not same. This means that there is significant difference in overall productivity ratios.

Table 7.29

Comparative Overall Productivity Ratios from 2010-11 to 2017-18 of Pharmaceutical Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	Cipla Ltd.		Dr. Reddy's Laboratories Ltd.		Lupin Ltd.		Sun Pharmaceutical Industries Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	0.9552	15	0.9516	14	1.0624	25	1.1008	27
2011-12	1.0038	20	0.9656	17	1.0054	21	1.1226	29
2012-13	0.9684	18	1.0173	23	1.0725	26	0.7504	6
2013-14	0.9632	16	1.0297	24	1.2367	32	0.5745	1
2014-15	0.8904	8	0.9882	19	1.1477	30	0.6008	3
2015-16	1.0055	22	0.9338	12	1.1628	31	0.5905	2
2016-17	0.9122	10	0.9422	13	1.1092	28	0.6430	4
2017-18	0.9185	11	0.8449	7	0.9083	9	0.7490	5
Total		120		129		202		77

H = 11.474

Testing Hypothesis and Interpretation: The calculated value of H is 11.474 and the table value is 7.815 at 5% level of significance with (4-1) = 3 degrees of freedom. As the calculated value is more than the table value hence null hypothesis is rejected and alternative hypothesis is accepted. This means that the overall productivity ratios of the pharmaceutical sector companies included in Nifty 50 are not same which shows that there is a significant difference in overall productivity.

Table 7.30

Comparative Overall Productivity Ratios from 2010-11 to 2017-18 of Refineries Sector Companies and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

Year	Bharat Petroleum Corporation Ltd.		Hindustan Petroleum Corporation Ltd.		Indian Oil Corporation Ltd.		Reliance Industries Ltd.	
	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	0.9896	5	0.9631	1	0.9932	7	1.0370	19
2011-12	1.0058	12	0.9994	9	1.0141	15	1.0410	24
2012-13	1.0051	11	1.0102	14	0.9889	4	1.0221	17
2013-14	1.0037	10	0.9992	8	1.0065	13	1.0372	20
2014-15	1.0622	30	1.0461	25	1.0409	23	1.0463	26
2015-16	1.0542	29	1.0221	16	1.0474	28	1.1041	32
2016-17	0.9871	3	0.9924	6	0.9745	2	1.0255	18
2017-18	1.0385	21	1.0404	22	1.0774	31	1.0465	27
Total		121		101		123		183

H = 5.347

Testing Hypothesis and Interpretation: The calculated value of H is 5.347 and the table value is 7.815 at 5% level of significance with (4-1) = 3 degrees of freedom. As the calculated value is less than the table value hence null hypothesis is accepted and alternative hypothesis is rejected which concludes that there is no significant difference in overall productivity ratios of the refineries sector companies included in Nifty 50.

7.5. Comparative Analysis of Average Overall Productivity Ratios

To analyse between the companies of a particular sector it is best to analyse its average performance for the study period. In the present study an attempt has been made to analyse and interpret the results on the basis of average performance.

Table 7.31

Comparative Analysis of Average Overall Productivity Ratios of Automobile Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Overall Input Output Ratio		Overall Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Value	Rank
Bajaj Auto Ltd.	0.8729	1	1.1465	1	0.159	1
Mahindra & Mahindra Ltd.	1.0073	3	0.9931	3	0.171	2
Maruti Suzuki India Ltd.	1.0050	2	0.9957	2	0.323	3
Tata Motors Ltd.	1.1462	4	0.8760	4	2.573	4

Average Overall Input Output Ratio: The average overall input output ratio is the best of Bajaj Auto Ltd. by 0.8729, followed by Maruti Suzuki India Ltd. by 1.0050, Mahindra & Mahindra Ltd. by 1.0073 and lastly Tata Motors Ltd. by 1.1462.

Average Overall Productivity Ratio: Average overall productivity ratio is the best of Bajaj Auto Ltd. with 1.1465 which means that for one ₹ of input, the output produced is ₹ 1.1465. This is followed by Maruti Suzuki India Ltd. with 0.9957 then Mahindra & Mahindra Ltd. with 0.9931 and lastly Tata Motors Ltd. with 0.8760.

Chi-square Test: On analysing the chi-square of the automobile sector companies included in Nifty 50 it has been observed that Bajaj Auto Ltd. has the least chi-square value with 0.159 then the Mahindra & Mahindra Ltd. with 0.171, followed by the Maruti Suzuki India Ltd. with 0.323 and lastly the highest chi-square value of Tata Motors Ltd. with 2.573. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square is accepted in all the above cases and the alternative hypothesis is rejected. This decides that the overall productivity ratios of all the companies of automobile sector included in Nifty 50 for the eight years period are approximately the same.

Table 7.32

Comparative Analysis of Average Overall Productivity Ratios of Energy Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Overall Input Output Ratio		Overall Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Value	Rank
GAIL (India) Ltd.	1.0244	1	0.9773	1	0.316	2
NTPC Ltd.	1.1979	3	0.8390	3	0.305	1
Oil and Natural Gas Corporation Ltd.	1.0458	2	0.9678	2	0.759	3
Power Grid Corporation of India Ltd.	1.7370	4	0.5791	4	3.586	4

Average Overall Input Output Ratio: The average overall input output ratio is the best of GAIL (India) Ltd. with 1.0244, followed by Oil and Natural Gas Corporation Ltd. by 1.0458, NTPC Ltd. with 1.1979 and lastly Power Grid Corporation of India Ltd. with 1.7370.

Average Overall Productivity Ratio: Average overall productivity ratio is the best of GAIL (India) Ltd. with 0.9773, followed by Oil and Natural Gas Corporation Ltd. with 0.9678, NTPC Ltd. with 0.8390 and lastly Power Grid Corporation of India Ltd. with 0.5791.

Chi-square Test: On analysing the chi-square of the energy sector companies included in Nifty 50 it has been observed that NTPC Ltd. has the least chi-square value with 0.305 then the GAIL (India) Ltd. with 0.316, Oil and Natural Gas Corporation Ltd. and lastly it is Power Grid Corporation of India Ltd. with the highest chi-square value 3.586. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square is accepted in all the above cases.

Table 7.33

Comparative Analysis of Average Overall Productivity Ratios of Information Technology Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Overall Input Output Ratio		Overall Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Value	Rank
Infosys Ltd.	0.9623	2	1.0397	2	0.286	1
Tata Consultancy Services Ltd.	0.8658	1	1.1560	1	0.314	2
Tech Mahindra Ltd.	1.0837	4	0.9256	4	1.455	4
Wipro Ltd.	1.0355	3	0.9668	3	0.627	3

Average Overall Input Output Ratio: The average overall input output ratio is the best of Tata Consultancy Services Ltd. by 0.8658, followed by Infosys Ltd. by 0.9623, Wipro Ltd. by 1.0355 and lastly 1.0837 of Tech Mahindra Ltd.

Average Overall Productivity Ratio: Average overall productivity ratio is the best of Tata Consultancy Services Ltd. with 1.1560, then Infosys Ltd. with 1.0397, Wipro Ltd. with 0.9668 and lastly Tech Mahindra Ltd. with 0.9256.

Chi-square Test: On analysing the chi-square of the information technology sector companies it has been observed that Infosys Ltd. has the least chi-square value and Tech Mahindra Ltd. has the highest chi-square value. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square is accepted in all the above cases.

Table 7.34

Comparative Analysis of Average Overall Productivity Ratios of Metals Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Overall Input Output Ratio		Overall Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Value	Rank
Coal India Ltd.	0.2798	1	4.5423	1	219.742	4
Hindalco Ltd.	1.2404	4	0.8077	4	0.991	1
Tata Steel Ltd.	1.1296	2	0.8888	3	1.964	2
Vedanta Ltd.	1.1481	3	0.9426	2	28.625	3

Average Overall Input Output Ratio: The average overall input output ratio is the best of Coal India Ltd. by 0.2798, followed by 1.1296 of Tata Steel Ltd. then 1.1481 of Vedanta Ltd. and lastly 1.2404 of Hindalco Ltd.

Average Overall Productivity Ratio: Average overall productivity ratio is the best of Coal India Ltd. with 4.5423 which means that for one ₹ of overall input, the output produced is approximately ₹ 5. This is followed by Vedanta Ltd., Tata Steel Ltd. and Hindalco Ltd.

Chi-square Test: On analysing the chi-square of the metals sector companies included in Nifty 50 it has been observed that the Hindalco Ltd. and Tata Steel Ltd. has the chi-square value less than the table value of 14.067 hence null hypothesis is accepted in both these companies while Vedanta Ltd. and Coal India

Ltd. has the chi-square value greater than the table value hence null hypothesis is rejected.

Table 7.35

Comparative Analysis of Average Overall Productivity Ratios of Pharmaceutical Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Overall Input Output Ratio		Overall Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Value	Rank
Cipla Ltd.	1.0521	3	0.9522	3	1.073	1
Dr. Reddy's Laboratories Ltd.	1.0460	2	0.9592	2	1.682	2
Lupin Ltd.	0.9263	1	1.0881	1	6.156	3
Sun Pharmaceutical Industries Ltd.	1.3901	4	0.7664	4	22.234	4

Average Overall Input Output Ratio: The average overall input output ratio is the best of Lupin Ltd. with 0.9263, followed by Dr. Reddy's Laboratories Ltd. with 1.0460, Cipla Ltd. with 1.0521 and lastly Sun Pharmaceutical Industries Ltd. with 1.3901.

Average Overall Productivity Ratio: Average overall productivity ratio is the best of Lupin Ltd. with 1.0881, followed by Dr. Reddy's Laboratories Ltd., Cipla Ltd. and Sun Pharmaceutical Industries Ltd.

Chi-square Test: On analysing the chi-square of the pharmaceutical sector companies included in Nifty 50 it has been observed that Cipla Ltd. has the least chi-square value with 1.073 then the Dr. Reddy's Laboratories Ltd., followed by Lupin Ltd. and lastly it is Sun Pharmaceutical Industries Ltd. with the highest chi-square value 22.234. The table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom is 14.067. This shows that the null hypothesis based on the chi-square is accepted in case of Cipla Ltd., Dr. Reddy's Laboratories Ltd. and Lupin Ltd. while it is rejected in case of Sun Pharmaceutical Industries Ltd.

Table 7.36

Comparative Analysis of Average Overall Productivity Ratios of Refineries Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	Overall Input Output Ratio		Overall Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Value	Rank
Bharat Petroleum Corporation Ltd.	0.9827	2	1.0183	2	0.466	3
Hindustan Petroleum Corporation Ltd.	0.9916	4	1.0091	4	0.312	1
Indian Oil Corporation Ltd.	0.9834	3	1.0179	3	0.612	4
Reliance Industries Ltd.	0.9574	1	1.0450	1	0.385	2

Average Overall Input Output Ratio: The average overall input output ratio is the best of Reliance Industries Ltd. by 0.9574, followed by 0.9827 of Bharat Petroleum Corporation Ltd., 0.9834 of Indian Oil Corporation Ltd. and lastly 0.9916 of Hindustan Petroleum Corporation Ltd.

Average Overall Productivity Ratio: Average overall productivity ratio is the best of Reliance Industries Ltd. with 1.0450, followed by Bharat Petroleum Corporation Ltd. with 1.0183, Indian Oil Corporation Ltd. with 1.0179 and lastly Hindustan Petroleum Corporation Ltd. with 1.0091.

Chi-square Test: On analysing the chi-square of the refineries sector companies it has been observed that Hindustan Petroleum Corporation Ltd. has the least chi-square value and Indian Oil Corporation Ltd. has the highest chi-square value. But all these values are below the table value of chi-square at 5% level of significance with (8-1) = 7 degree of freedom. This shows that the null hypothesis based on the chi-square is accepted in all the above cases.

7.6. Overall Productivity Ranking of Sampled Companies: At a Glance

Overall productivity of all the companies of all sectors under the study are taken together and analysed. Table 7.37 states the overall productivity of all the companies for the years under the study and rank is allowed to each one of them. The company having the highest productivity has been ranked first.

Table 7.37

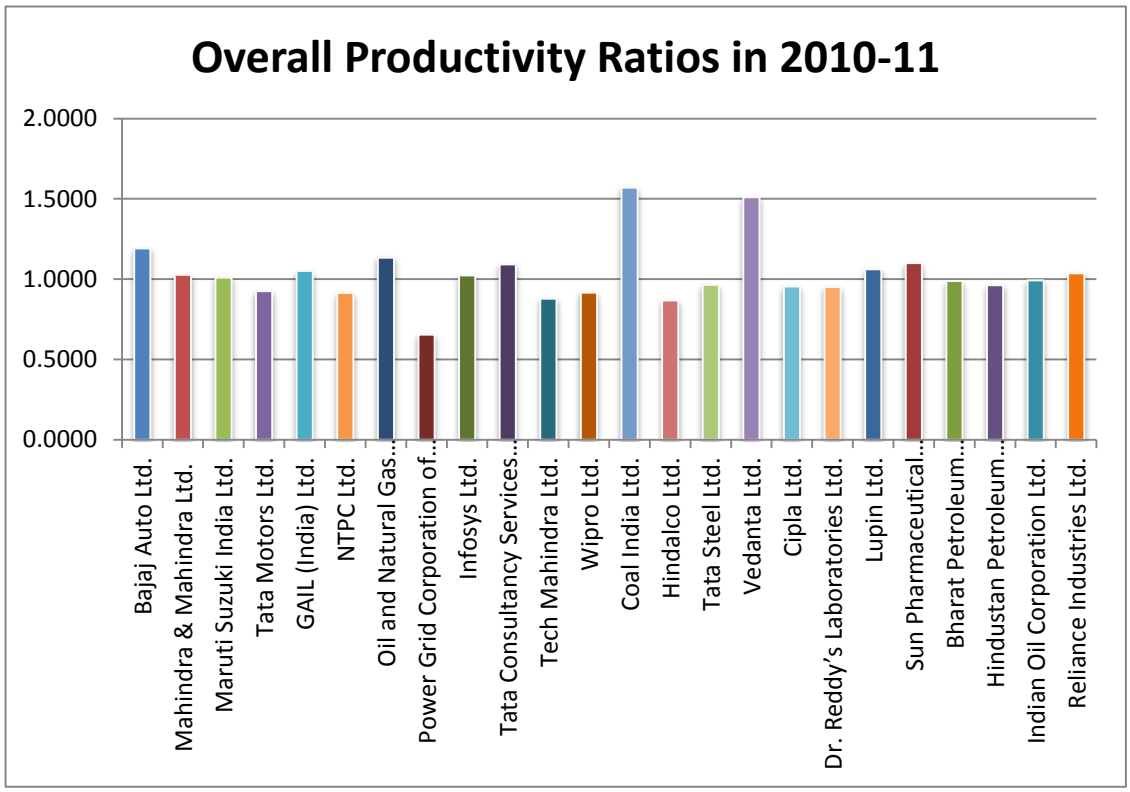
Overall Productivity Ranking of Sampled Companies: At a Glance from 2010-11 to 2017-18

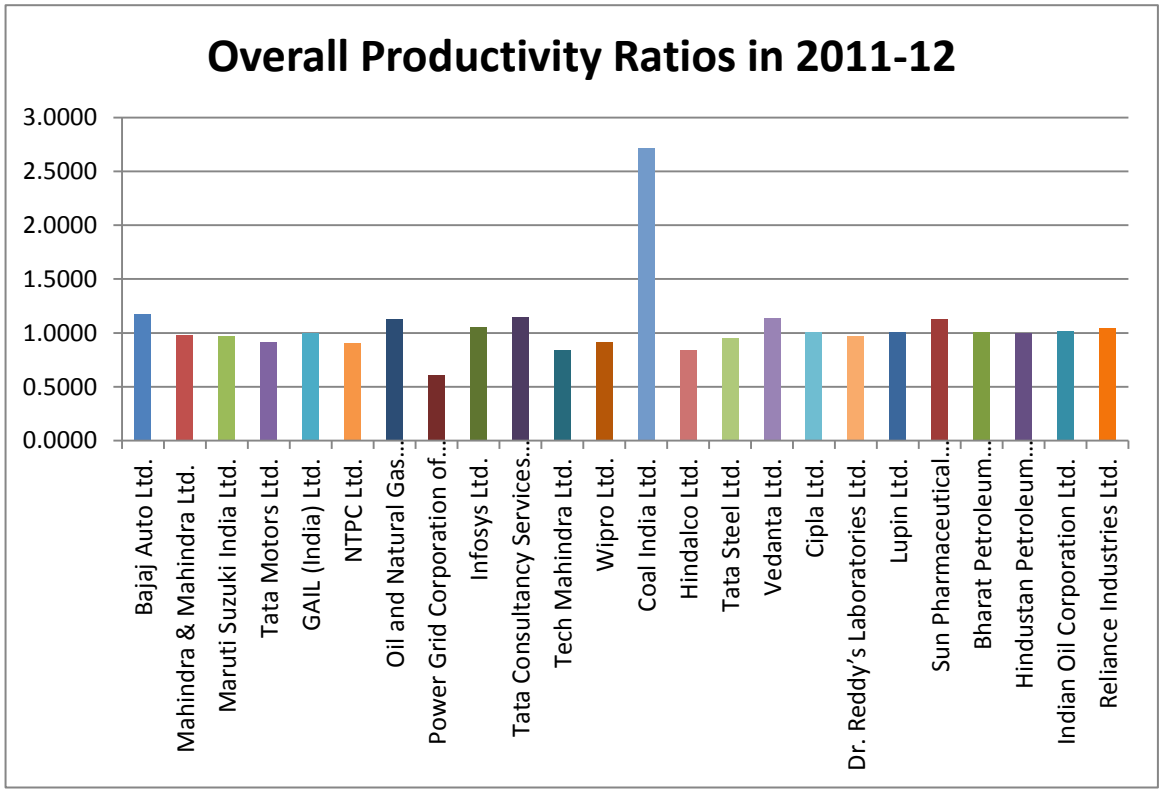
Years	2010-11		2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18		Overall	
Companies	Overall Productivity	Rank	Overall Productivity	Rank	Overall Productivity	Rank	Overall Productivity	Rank	Overall Productivity	Rank	Overall Productivity	Rank	Overall Productivity	Rank	Overall Productivity	Rank	Average	Rank
Bajaj Auto Ltd.	1.1922	3	1.1743	2	1.1613	2	1.1585	4	1.1177	4	1.1658	3	1.1048	4	1.0979	3	1.1465	3
Mahindra & Mahindra Ltd.	1.0280	10	0.9794	15	1.0163	7	0.9899	13	0.9978	10	0.9746	14	0.9695	11	0.9897	10	0.9931	11
Maruti Suzuki India Ltd.	1.0108	12	0.9665	16	0.9752	15	0.9729	15	0.9718	13	1.0123	10	1.0245	6	1.0315	9	0.9957	10
Tata Motors Ltd.	0.9260	19	0.9181	19	0.8984	18	0.8709	19	0.7647	22	0.8875	19	0.8174	20	0.9248	14	0.8760	20
GAIL (India) Ltd.	1.0522	8	0.9945	14	0.9989	12	0.9649	16	0.9518	14	0.9399	16	0.9514	13	0.9650	12	0.9773	12
NTPC Ltd.	0.9147	21	0.9052	21	0.9037	17	0.8595	20	0.8015	21	0.7785	22	0.7869	21	0.7622	22	0.8390	21
Oil and Natural Gas Corporation Ltd.	1.1344	4	1.1288	5	1.0145	8	0.9756	14	0.8891	18	0.8949	18	0.8514	18	0.8536	18	0.9678	13
Power Grid Corporation of India Ltd.	0.6552	24	0.6085	24	0.5824	23	0.5290	24	0.5085	24	0.5541	24	0.5956	24	0.5993	24	0.5791	24
Infosys Ltd.	1.0240	11	1.0497	7	1.0120	9	1.0181	7	1.0537	6	1.0683	6	1.0204	7	1.0712	5	1.0397	6
Tata Consultancy Services Ltd.	1.0927	6	1.1494	3	1.1158	3	1.1746	3	1.1739	2	1.1990	2	1.1540	2	1.1887	2	1.1560	2
Tech Mahindra Ltd.	0.8792	22	0.8415	22	0.8766	20	0.9912	12	0.9444	15	0.9890	13	0.9380	15	0.9448	13	0.9256	18
Wipro Ltd.	0.9168	20	0.9136	20	0.9768	14	1.0054	9	0.9931	11	0.9907	12	0.9602	12	0.9776	11	0.9668	14
Coal India Ltd.	1.5708	1	2.7146	1	3.0637	1	6.3331	1	5.3559	1	7.1470	1	6.3928	1	3.7608	1	4.5423	1
Hindalco Ltd.	0.8679	23	0.8398	23	0.7977	21	0.7528	22	0.8198	19	0.7983	21	0.7702	22	0.8152	21	0.8077	22
Tata Steel Ltd.	0.9655	15	0.9520	18	0.8921	19	0.9032	18	0.8056	20	0.8387	20	0.8284	19	0.9247	15	0.8888	19
Vedanta Ltd.	1.5113	2	1.1426	4	0.5344	24	0.7780	21	0.8897	17	0.9735	15	0.8813	17	0.8296	20	0.9426	17
Cipla Ltd.	0.9552	17	1.0038	12	0.9684	16	0.9632	17	0.8904	16	1.0055	11	0.9122	16	0.9185	16	0.9522	16
Dr. Reddy's Laboratories Ltd.	0.9516	18	0.9656	17	1.0173	6	1.0297	6	0.9882	12	0.9338	17	0.9422	14	0.8449	19	0.9592	15
Lupin Ltd.	1.0624	7	1.0054	11	1.0725	4	1.2367	2	1.1477	3	1.1628	4	1.1092	3	0.9083	17	1.0881	4
Sun Pharmaceutical Industries Ltd.	1.1008	5	1.1226	6	0.7504	22	0.5745	23	0.6008	23	0.5905	23	0.6430	23	0.7490	23	0.7664	23
Bharat Petroleum Corporation Ltd.	0.9896	14	1.0058	10	1.0051	11	1.0037	10	1.0622	5	1.0542	7	0.9871	9	1.0385	8	1.0183	7
Hindustan Petroleum Corporation Ltd.	0.9631	16	0.9994	13	1.0102	10	0.9992	11	1.0461	8	1.0221	9	0.9924	8	1.0404	7	1.0091	9
Indian Oil Corporation Ltd.	0.9932	13	1.0141	9	0.9889	13	1.0065	8	1.0409	9	1.0474	8	0.9745	10	1.0774	4	1.0179	8
Reliance Industries Ltd.	1.0370	9	1.0410	8	1.0221	5	1.0372	5	1.0463	7	1.1041	5	1.0255	5	1.0465	6	1.0450	5

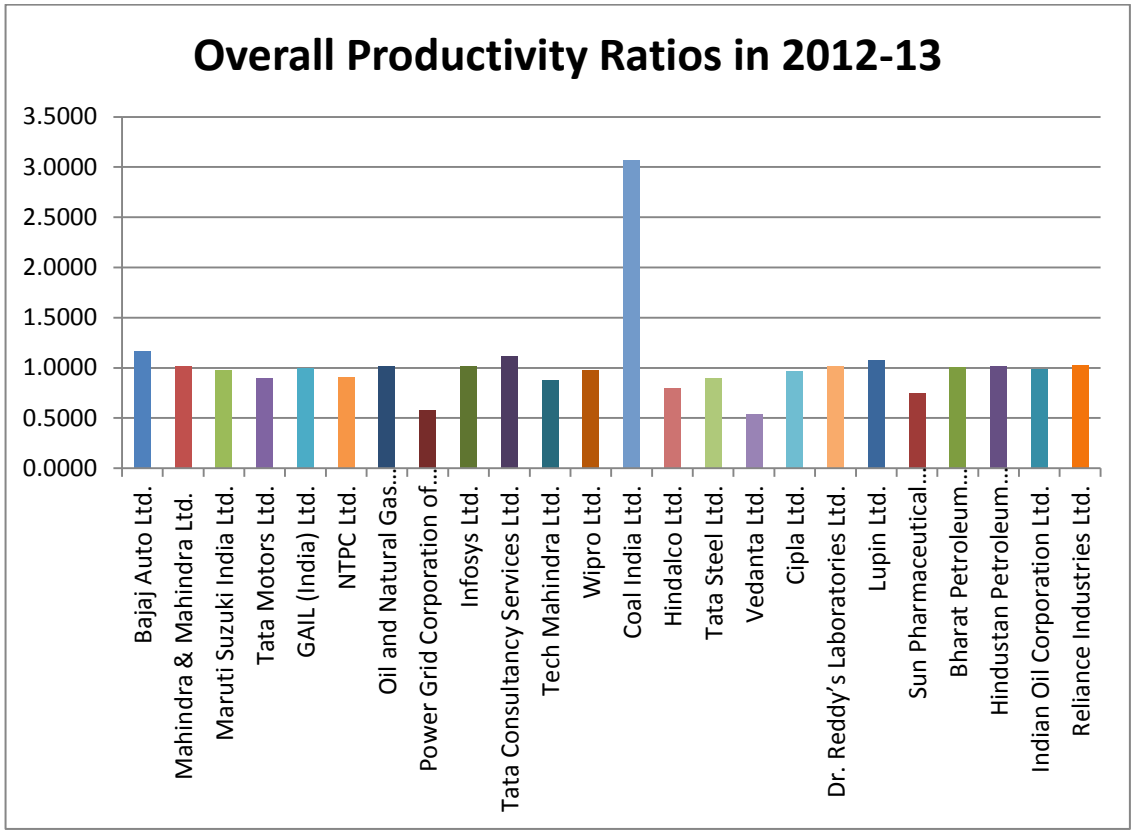
According to the table 7.37, overall productivity is the best in Coal India Ltd., followed by Vedanta Ltd. and Bajaj Auto Ltd. in 2010-11. Coal India Ltd. is the best in 2011-12 and 2012-13, followed by Bajaj Auto Ltd. and Tata Consultancy Services Ltd. In 2013-14, Coal India Ltd. marked the best performance related to the productivity, followed by Lupin Ltd. and Tata Consultancy Services Ltd. In 2014-15 and 2016-17, Coal India Ltd. is the best, followed by Tata Consultancy Services Ltd. and Lupin Ltd. In 2015-16 and 2017-18, overall productivity is the best in Coal India Ltd., followed by Tata Consultancy Services Ltd. and Bajaj Auto Ltd.

By analysing the overall productivity of all companies during all the years under study, it has been observed that overall productivity is the best in Coal India Ltd., followed by Tata Consultancy Services Ltd. and Bajaj Auto Ltd.

7.7. Overall Productivity Ratios of Sampled Companies: At a Glance






Overall Productivity Ratios in 2012-13
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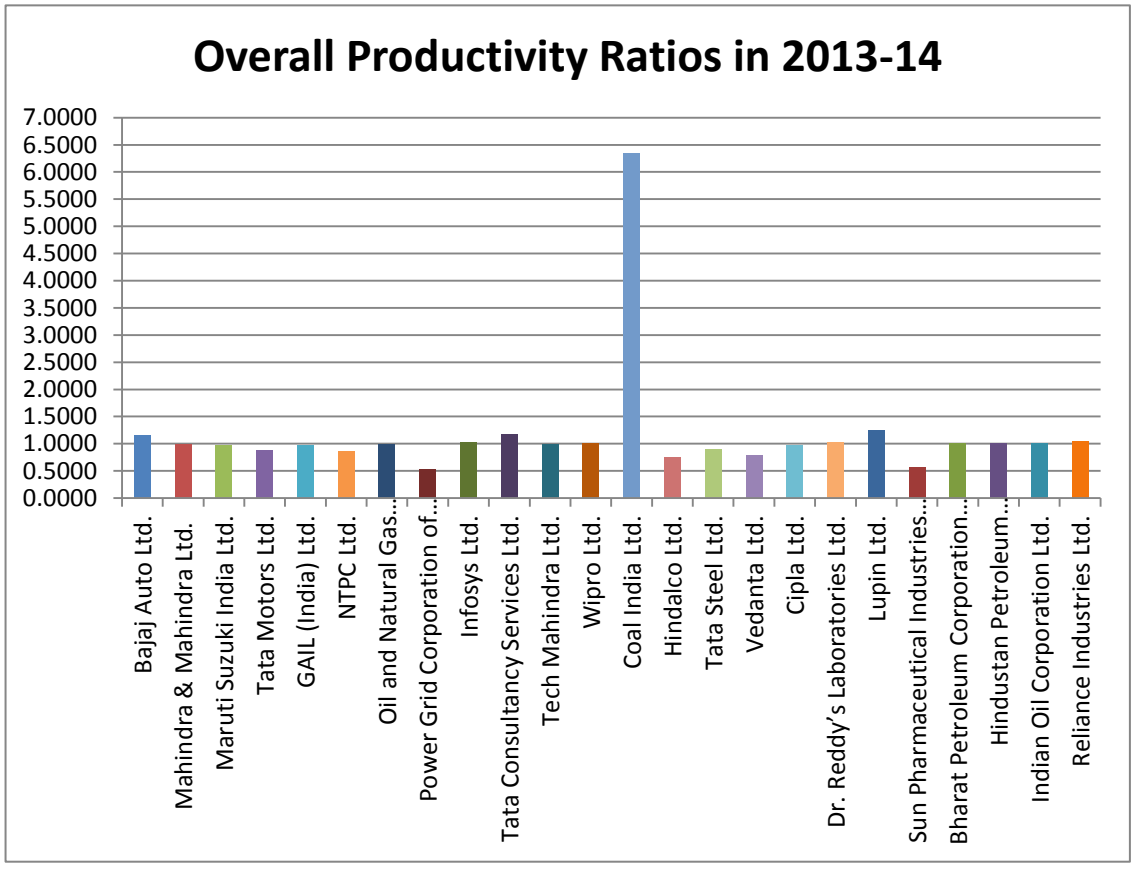
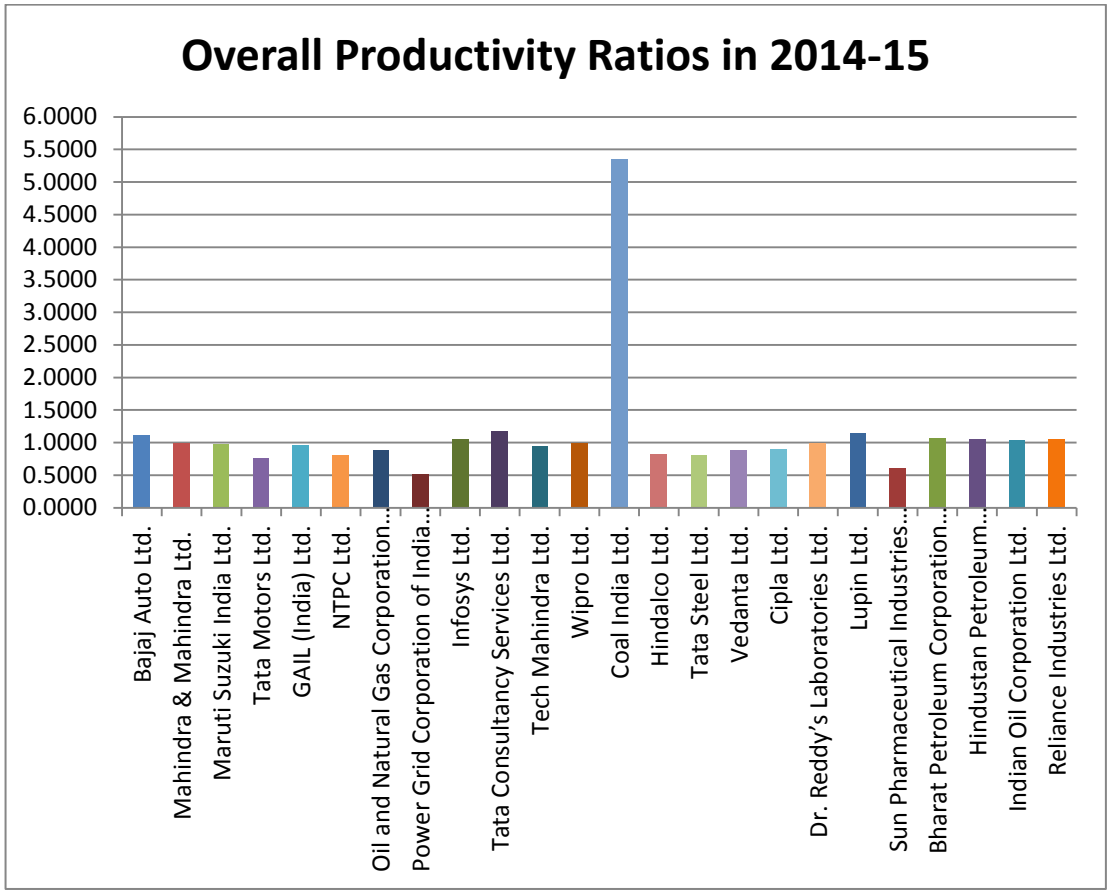
3.0000
2.5000
2.0000
1.5000
1.0000
0.5000
0.0000
Bajaj Auto Ltd.
Mahindra & Mahindra Ltd.
Maruti Suzuki India Ltd.
Tata Motors Ltd.
GAIL (India) Ltd.
NTPC Ltd.
Oil and Natural Gas...
Power Grid Corporation of...
Infosys Ltd.
Tata Consultancy Services Ltd.
Tech Mahindra Ltd.
Wipro Ltd.
Coal India Ltd.
Hindalco Ltd.
Tata Steel Ltd.
Vedanta Ltd.
Cipla Ltd.
Dr. Reddy's Laboratories Ltd.
Lupin Ltd.
Sun Pharmaceutical...
Bharat Petroleum...
Hindustan Petroleum...
Indian Oil Corporation Ltd.
Reliance Industries Ltd.


Overall Productivity Ratios in 2013-14
7.0000
6.5000
6.0000
5.5000
5.0000
4.5000
4.0000
3.5000
3.0000
2.5000
2.0000
1.5000
1.0000
0.5000
0.0000
Bajaj Auto Ltd.
Mahindra & Mahindra Ltd.
Maruti Suzuki India Ltd.
Tata Motors Ltd.
GAIL (India) Ltd.
NTPC Ltd.
Oil and Natural Gas...
Power Grid Corporation of...
Infosys Ltd.
Tata Consultancy Services Ltd.
Tech Mahindra Ltd.
Wipro Ltd.
Coal India Ltd.
Hindalco Ltd.
Tata Steel Ltd.
Vedanta Ltd.
Cipla Ltd.
Dr. Reddy's Laboratories Ltd.
Lupin Ltd.
Sun Pharmaceutical Industries...
Bharat Petroleum Corporation...
Hindustan Petroleum...
Indian Oil Corporation Ltd.
Reliance Industries Ltd.


Overall Productivity Ratios in 2014-15
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5.5000
5.0000
4.5000
4.0000
3.5000
3.0000
2.5000
2.0000
1.5000
1.0000
0.5000
0.0000
Bajaj Auto Ltd.
Mahindra & Mahindra Ltd.
Maruti Suzuki India Ltd.
Tata Motors Ltd.
GAIL (India) Ltd.
NTPC Ltd.
Oil and Natural Gas Corporation...
Power Grid Corporation of India...
Infosys Ltd.
Tata Consultancy Services Ltd.
Tech Mahindra Ltd.
Wipro Ltd.
Coal India Ltd.
Hindalco Ltd.
Tata Steel Ltd.
Vedanta Ltd.
Cipla Ltd.
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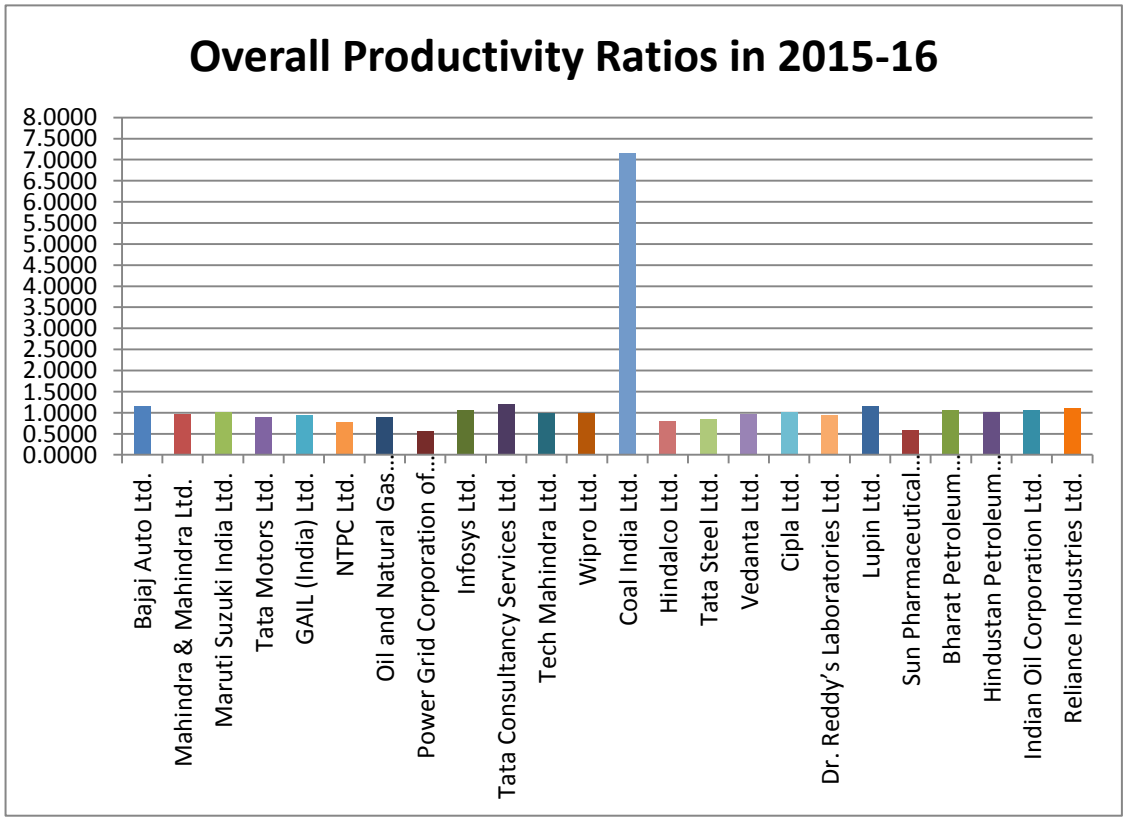
Lupin Ltd.
Sun Pharmaceutical Industries...
Bharat Petroleum Corporation...
Hindustan Petroleum...
Indian Oil Corporation Ltd.
Reliance Industries Ltd.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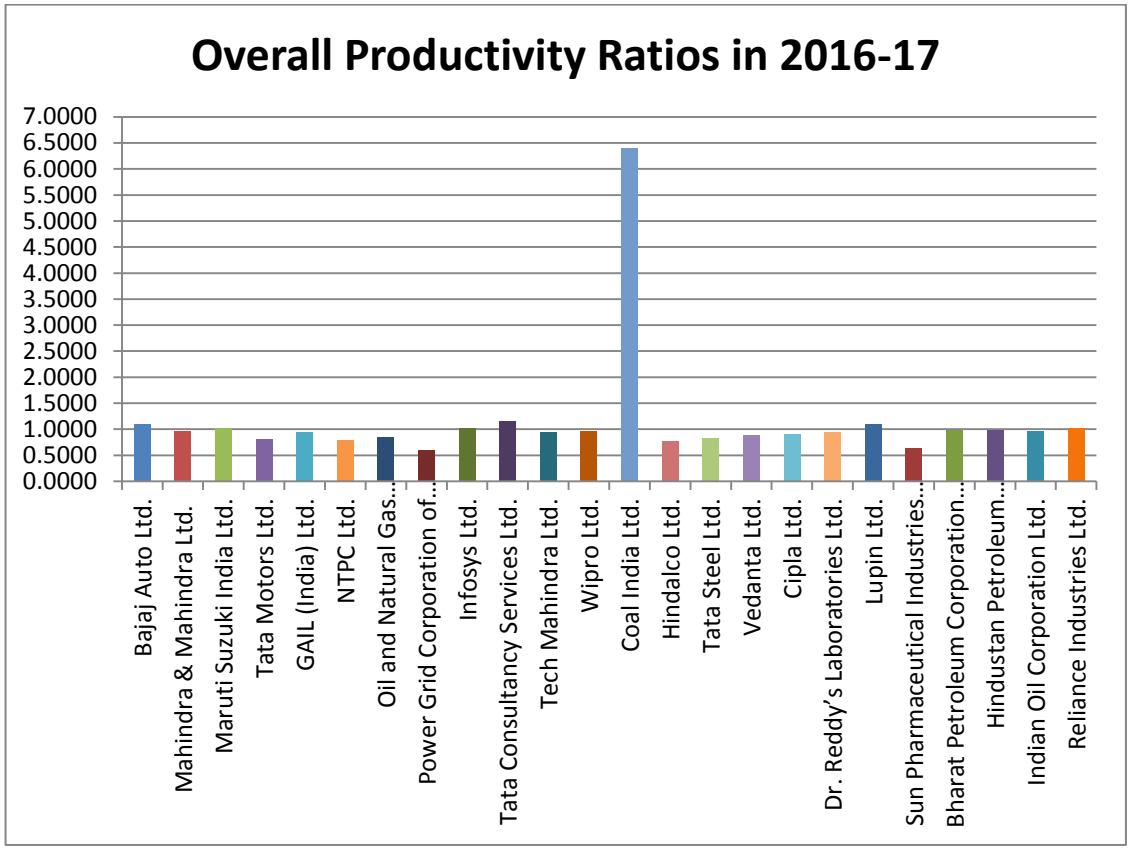
6.0000
5.5000
5.0000
4.5000
4.0000
3.5000
3.0000
2.5000
2.0000
1.5000
1.0000
0.5000
0.0000
Bajaj Auto Ltd.
Mahindra & Mahindra Ltd.
Maruti Suzuki India Ltd.
Tata Motors Ltd.
GAIL (India) Ltd.
NTPC Ltd.
Oil and Natural Gas...
Power Grid Corporation of...
Infosys Ltd.
Tata Consultancy Services Ltd.
Tech Mahindra Ltd.
Wipro Ltd.
Coal India Ltd.
Hindalco Ltd.
Tata Steel Ltd.
Vedanta Ltd.
Cipla Ltd.
Dr. Reddy's Laboratories Ltd.
Lupin Ltd.
Sun Pharmaceutical...
Bharat Petroleum...
Hindustan Petroleum...
Indian Oil Corporation Ltd.
Reliance Industries Ltd.


Overall Productivity Ratios in 2016-17
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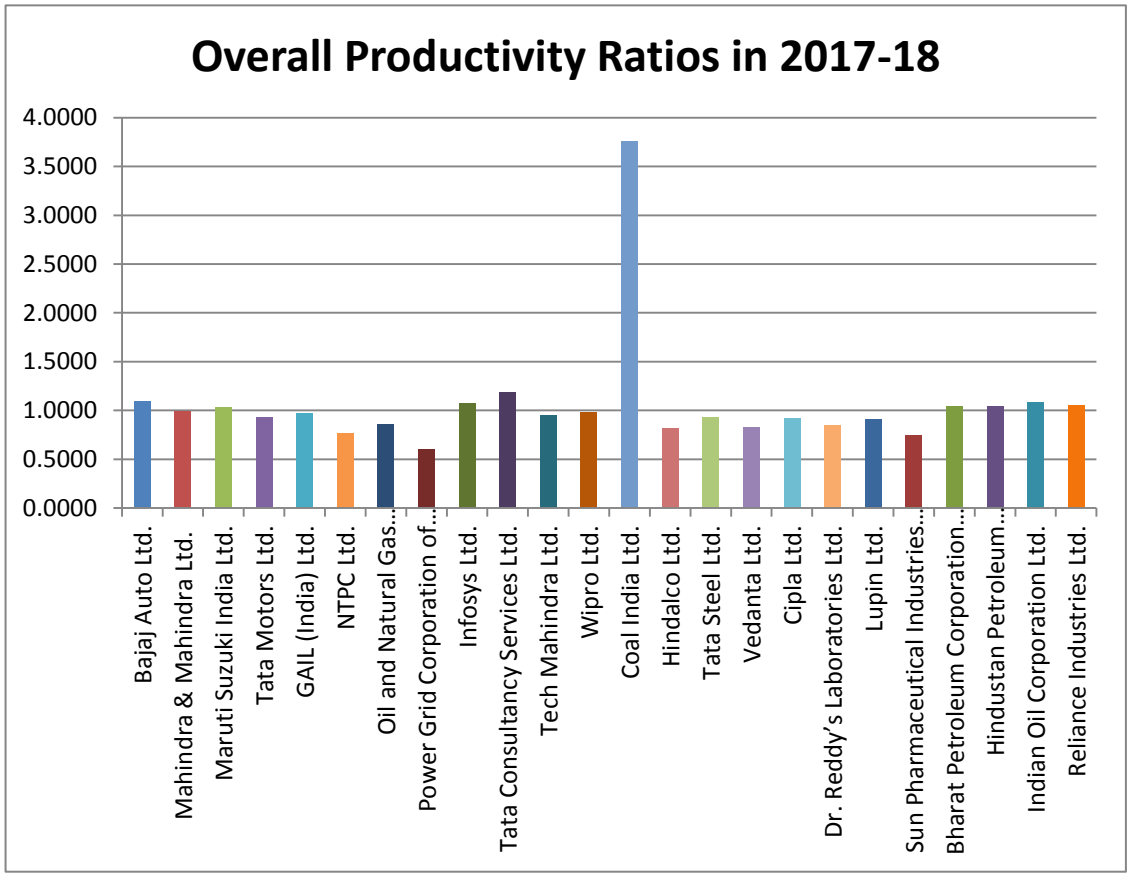
6.0000
5.5000
5.0000
4.5000
4.0000
3.5000
3.0000
2.5000
2.0000
1.5000
1.0000
0.5000
0.0000
Bajaj Auto Ltd.
Mahindra & Mahindra Ltd.
Maruti Suzuki India Ltd.
Tata Motors Ltd.
GAIL (India) Ltd.
NTPC Ltd.
Oil and Natural Gas...
Power Grid Corporation of...
Infosys Ltd.
Tata Consultancy Services Ltd.
Tech Mahindra Ltd.
Wipro Ltd.
Coal India Ltd.
Hindalco Ltd.
Tata Steel Ltd.
Vedanta Ltd.
Cipla Ltd.
Dr. Reddy's Laboratories Ltd.
Lupin Ltd.
Sun Pharmaceutical Industries...
Bharat Petroleum Corporation...
Hindustan Petroleum...
Indian Oil Corporation Ltd.
Reliance Industries Ltd.


Overall Productivity Ratios in 2017-18
4.0000
3.5000
3.0000
2.5000
2.0000
1.5000
1.0000
0.5000
0.0000
Bajaj Auto Ltd.
Mahindra & Mahindra Ltd.
Maruti Suzuki India Ltd.
Tata Motors Ltd.
GAIL (India) Ltd.
NTPC Ltd.
Oil and Natural Gas...
Power Grid Corporation of...
Infosys Ltd.
Tata Consultancy Services Ltd.
Tech Mahindra Ltd.
Wipro Ltd.
Coal India Ltd.
Hindalco Ltd.
Tata Steel Ltd.
Vedanta Ltd.
Cipla Ltd.
Dr. Reddy's Laboratories Ltd.
Lupin Ltd.
Sun Pharmaceutical Industries...
Bharat Petroleum Corporation...
Hindustan Petroleum...
Indian Oil Corporation Ltd.
Reliance Industries Ltd.

7.8. Concluding Observations

Overall productivity means the productivity of all factors taken together. All the inputs viz., material, labour, overhead and investor input is added and total input is calculated and compared with the output values and overall productivity is calculated. This chapter explains the calculation of investor input element of overall input which is based on the percentage of average investment. On adding the material, labour, overhead and investor input, overall input is obtained and consequently overall productivity is calculated. By analysing the overall productivity of all companies during all the years under study, it has been observed that overall productivity is the best in Coal India Ltd., followed by Tata Consultancy Services Ltd. and Bajaj Auto Ltd.

Next chapter highlights the summary of findings and suggestions. It also includes limitations faced during the research work.

Appendices

Appendix 7.1 to 7.4. Revaluation of Average Investment and Normal Investor Input of Automobile Sector Companies

Appendix 7.1

Revaluation of Average Investment and Normal Investor Input of Bajaj Auto Ltd. from 2010-11 to 2017-18.

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	1552.57	1523.38	1523.38	2097.98	2097.98	2150.10	2150.10	2172.18	2172.18	2077.91	2077.91	2043.96	2043.96	1934.80	1934.80
Add: Non Current Investments	4035.08	3786.21	3475.74	3719.15	3194.75	6259.93	5108.10	3352.76	2702.32	8294.34	6942.36	8681.39	7144.78	11822.89	9446.49
Add: Long Term Loans and Advances	226.96	579.9	532.35	462.39	397.19	719.92	587.45	511.07	411.92	682.24	571.03	429.70	353.64	469.32	374.99
Add: Other Non Current Assets	401.77	1.43	1.31	1.02	0.88	1.02	0.83	0.04	0.03	0.02	0.02	268.47	220.95	356.85	285.12
Add: Current Assets	3031.15	5190.15	4764.56	6198.08	5324.15	5616.63	4583.17	9526.27	7678.17	4618.25	3865.48	9391.37	7729.10	9235.63	7379.27
Total	9247.53	11081.07	10297.34	12478.62	11014.95	14747.60	12429.66	15562.32	12964.63	15672.76	13456.80	20814.89	17492.44	23819.49	19420.67
Less: Current Liabilities	3855.47	4625.16	4245.90	4133.63	3550.79	4730.24	3859.88	4476.79	3608.29	2953.02	2471.68	3212.58	2643.95	4111.29	3284.92
Net Capital Employed	5392.06	6455.91	6051.44	8344.99	7464.16	10017.36	8569.78	11085.53	9356.34	12719.74	10985.12	17602.31	14848.48	19708.20	16135.75
Less: Half of Profit (PAT)	1669.86	1502.02	1378.85	1521.78	1307.21	1621.66	1323.27	1406.87	1133.94	1826.21	1528.54	1913.78	1575.04	2034.05	1625.21
Average Investment	3722.20	4953.89	4672.59	6823.21	6156.95	8395.70	7246.51	9678.66	8222.40	10893.53	9456.58	15688.53	13273.44	17674.15	14510.54
Normal Investor Input @ 19.79 % Base Year Industry Standard	736.62		924.71		1218.46		1434.08		1627.21		1871.46		2626.81		2871.64

Appendix 7.2

Revaluation of Average Investment and Normal Investor Input of Mahindra & Mahindra Ltd. from 2010-11 to 2017-18.

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	3906.59	5080.75	5080.75	5821.34	5821.34	7105.39	7105.39	8108.22	8108.22	9518.38	9518.38	9811.44	9811.44	10988.12	10988.12
Add : Non Current Investments	8205.36	9273.56	8513.13	10571.5	9080.92	9787.73	7986.79	11372.74	9166.43	11144.66	9328.08	14301.70	11770.30	16645.48	13299.74
Add: Long Term Loans and Advances	1868.13	1476.68	1355.59	2087.47	1793.14	3018.12	2462.79	3232.26	2605.20	4057.44	3396.08	1157.44	952.57	1168.82	933.89
Add: Other Non Current Assets	117.02	90.27	82.87	29.85	25.64	88.49	72.21	103.44	83.37	58.66	49.10	2089.74	1719.86	2139.86	1709.75
Add: Current Assets	5442.68	7990.72	7335.48	8943.43	7682.41	11288.92	9211.76	10128.21	8163.34	11633.20	9736.99	12608.00	10376.38	16474.47	13163.10
Total	19539.78	23911.98	22367.82	27453.59	24403.44	31288.65	26838.93	32944.87	28126.56	36412.34	32028.62	39968.32	34630.55	47416.75	40094.6
Less: Current Liabilities	5951.43	7360.17	6756.64	8150.39	7001.19	8766.79	7153.70	8974.27	7233.26	10693.67	8950.60	9634.05	7928.82	13323.21	10645.24
Net Capital Employed	13588.35	16551.81	15611.18	19303.2	17402.26	22521.86	19685.23	23970.6	20893.3	25718.67	23078.02	30334.27	26701.73	34093.54	29449.35
Less: Half of Profit(PAT)	1331.05	1439.45	1321.41	1676.41	1440.04	1879.18	1533.41	1660.56	1338.41	1583.74	1325.59	1821.70	1499.25	2178.01	1740.23
Average Investment	12257.30	15112.37	14289.77	17626.79	15962.22	20642.69	18151.82	22310.05	19554.89	24134.93	21752.43	28512.58	25202.47	31915.54	27709.12
Normal Investor Input @ 19.79 % Base Year Industry Standard	2425.72		2827.95		3158.92		3592.25		3869.91		4304.81		4987.57		5483.64

Appendix 7.3

Revaluation of Average Investment and Normal Investor Input of Maruti Suzuki India Ltd. from 2010-11 to 2017-18.

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	6391.90	8132.10	8132.10	11740.10	11740.10	13411.80	13411.80	14142.10	14142.10	13774.70	13774.70	14545.00	14545.00	15484.90	15484.90
Add : Non Current Investments	1111.20	1393.30	1279.05	1873.50	1609.34	1304.80	1064.72	9817.60	7912.99	16912.70	14155.93	26302.20	21646.71	34072.90	27224.25
Add: Long Term Loans and Advances	1254.70	1671.50	1534.44	1280.00	1099.52	1638.40	1336.93	1349.30	1087.54	1349.70	1129.70	24.10	19.83	32.60	26.05
Add: Other Non Current Assets	47.10	26.30	24.14	894.60	768.46	9.00	7.34	44.10	35.54	9.00	7.53	1603.10	1319.35	1858.30	1484.78
Add: Current Assets	9620.20	11079.00	10170.52	10946.00	9402.61	14171.70	11564.11	8196.20	6606.14	7149.50	5984.13	8776.20	7222.81	7921.40	6329.20
Total	18425.10	22302.20	21140.25	26734.20	24620.03	30535.70	27384.90	33549.30	29784.30	39195.60	35051.99	51250.60	44753.71	59370.10	50549.17
Less: Current Liabilities	4018.70	6547.60	6010.70	6727.50	5778.92	8074.10	6588.47	8821.30	7109.97	11290.00	9449.73	13226.40	10885.33	15442.10	12338.24
Net Capital Employed	14406.40	15754.60	15129.56	20006.70	18841.11	22461.60	20796.44	24728.00	22674.34	27905.60	25602.26	38024.20	33868.38	43928.00	38210.94
Less: Half of Profit (PAT)	1144.30	817.60	750.56	1196.05	1027.41	1391.50	1135.46	1855.60	1495.61	2285.70	1913.13	3675.10	3024.61	3860.90	3084.86
Average Investment	13262.10	14937.00	14379.00	18810.65	17813.70	21070.10	19660.97	22872.40	21178.72	25619.90	23689.13	34349.10	30843.77	40067.10	35126.08
Normal Investor Input @ 19.79 % Base Year Industry Standard	2624.57		2845.60		3525.33		3890.91		4191.27		4688.08		6103.98		6951.45

Appendix 7.4

Revaluation of Average Investment and Normal Investor Input of Tata Motors Ltd. from 2010-11 to 2017-18.

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	17216.10	19056.19	19056.19	20208.54	20208.54	21595.64	21595.64	21824.02	21824.02	22244.86	22244.86	28043.91	28043.91	26800.35	26800.35
Add : Non Current Investments	22538.21	17903.29	16435.22	18171.71	15609.50	18357.57	14979.78	16966.95	13675.36	16975.46	14208.46	14858.39	12228.45	14260.79	11394.37
Add: Long Term Loans and Advances	3429.64	3488.11	3202.08	3575.24	3071.13	2918.30	2381.33	2403.56	1937.27	2363.22	1978.02	1360.45	1119.65	1633.11	1304.85
Add: Other Non Current Assets	34.84	358.77	329.35	94.32	81.02	123.85	101.06	175.67	141.59	136.80	114.50	1858.45	1529.50	1546.39	1235.57
Add: Current Assets	10971.66	13712.92	12588.46	10134.96	8705.93	6739.06	5499.07	8572.97	6909.81	10705.91	8960.85	12757.08	10499.08	14971.66	11962.36
Total	54190.45	54519.28	51611.31	52184.77	47676.12	49734.42	44556.88	49943.17	44488.05	52426.25	47506.68	58878.28	53420.60	59212.30	52697.50
Less: Current Liabilities	19000.27	22177.47	20358.92	21104.61	18128.86	18797.53	15338.78	20370.63	16418.73	17751.06	14857.64	21538.35	17726.06	24218.95	19350.94
Net Capital Employed	35190.18	32341.81	31252.39	31080.16	29547.26	30936.89	29218.10	29572.54	28069.33	34675.19	32649.05	37339.93	35694.53	34993.35	33346.56
Less: Half of Profit (PAT)	905.91	621.11	621.11	150.91	150.91	167.26	167.26	-2369.48	-2369.48	117.11	117.11	-1214.80	-1214.80	-517.42	-517.42
Average Investment	34284.27	31720.70	30631.28	30929.25	29396.35	30769.63	29050.84	31942.02	30438.80	34558.08	32531.94	38554.73	36909.33	35510.77	33863.98
Normal Investor Input @ 19.79 % Base Year Industry Standard	6784.86		6061.93		5817.54		5749.16		6023.84		6438.07		7304.36		6701.68

Appendix 7.5 to 7.8. Revaluation of Average Investment and Normal Investor Input of Energy Sector Companies

Appendix 7.5

Revaluation of Average Investment and Normal Investor Input of GAIL (India) Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	18249.72	23800.07	23800.07	28685.27	28685.27	31204.48	31204.48	32119.71	32119.71	32149.27	32149.27	32309.58	32309.58	34303.79	34303.79
Add : Non Current Investments	2581.35	3548.93	3257.92	3680.05	3161.16	4103.00	3348.05	4322.36	3483.82	4534.33	3795.23	9377.08	7717.34	9571.60	7647.71
Add: Long Term Loans and Advances	1687.10	1995.58	1831.94	2591.49	2226.09	2535.12	2068.66	3445.88	2777.38	4439.28	3715.68	3274.80	2695.16	3166.95	2530.39
Add: Other Non Current Assets	73.09	272.11	249.80	673.19	578.27	718.41	586.22	2409.95	1942.42	1115.54	933.71	1244.28	1024.04	931.21	744.04
Add: Current Assets	9420.19	9467.99	8691.61	9054.19	7777.55	11250.32	9180.26	10595.33	8539.84	10755.84	9002.64	9131.22	7514.99	10108.63	8076.80
Total	32011.45	39084.68	37831.34	44684.19	42428.34	49811.33	46387.67	52893.23	48863.17	52994.26	49596.53	55336.96	51261.11	58082.18	53302.72
Less: Current Liabilities	8847.68	10186.46	9351.17	8970.90	7706.00	9471.33	7728.61	9992.24	8053.75	10882.27	9108.46	8374.84	6892.49	9901.55	7911.34
Net Capital Employed	23163.77	28898.22	28480.17	35713.29	34722.34	40340.00	38659.06	42900.99	40809.42	42111.99	40488.07	46962.12	44368.62	48180.63	45391.39
Less: Half of Profit (PAT)	1780.57	1826.92	1826.92	2011.10	2011.10	2187.64	2187.64	1519.59	1519.59	1149.45	1149.45	1751.46	1751.46	2309.21	2309.21
Average Investment	21383.21	27071.30	26653.25	33702.19	32711.24	38152.37	36471.43	41381.41	39289.84	40962.54	39338.62	45210.67	42617.17	45871.43	43082.18
Normal Investor Input @ 16.04 % Base Year Industry Standard	3429.87		4275.18		5246.88		5850.02		6302.09		6309.91		6835.79		6910.38

Appendix 7.6

Revaluation of Average Investment and Normal Investor Input of NTPC Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	74731.29	87086.22	87086.22	100045.52	100045.5	116999.50	116999.5	135342.56	135342.56	158063.46	158063.46	180092.81	180092.8	198835.44	198835.4
Add : Non Current Investments	10532.84	9583.92	8798.04	9137.64	7849.23	8120.90	6626.65	7154.07	5766.18	7949.52	6653.75	8248.11	6788.19	10047.48	8027.94
Add: Long Term Loans and Advances	3901.96	3883.26	3564.83	9633.41	8275.10	12776.22	10425.40	15527.89	12515.48	16980.19	14212.42	2440.36	2008.42	2288.53	1828.54
Add: Other Non Current Assets	459.15	1371.88	1259.39	1491.19	1280.93	1786.77	1458.00	1746.77	1407.90	1879.78	1573.38	16873.48	13886.87	11568.68	9243.38
Add: Current Assets	36113.64	38912.52	35721.69	40808.70	35054.67	39870.79	32534.56	37363.43	30114.92	29746.31	24897.66	28439.99	23406.11	37453.43	29925.29
Total	125738.88	140837.80	136430.17	161116.46	152505.46	179554.18	168044.12	197134.72	185147.04	214619.26	205400.66	236094.75	226182.41	260193.56	247860.58
Less: Current Liabilities	14041.04	17238.64	15825.07	22606.18	19418.71	25279.80	20628.32	30519.52	24598.73	33846.39	28329.43	36177.32	29773.93	42554.76	34001.25
Net Capital Employed	111697.84	123599.16	120605.10	138510.28	133086.75	154274.38	147415.80	166615.20	160548.31	180772.87	177071.24	199917.43	196408.47	217638.80	213859.32
Less: Half of Profit (PAT)	4551.30	4611.87	4611.87	6309.70	6309.70	5487.37	5487.37	5145.43	5145.43	5121.46	5121.46	4692.63	4692.63	5171.59	5171.59
Average Investment	107146.55	118987.30	115993.23	132200.59	126777.05	148787.01	141928.43	161469.77	155402.88	175651.42	171949.78	195224.80	191715.84	212467.22	208687.74
Normal Investor Input @ 16.04 % Base Year Industry Standard	17186.31		18605.31		20335.04		22765.32		24926.62		27580.74		30751.22		33473.51

Appendix 7.7

Revaluation of Average Investment and Normal Investor Input of Oil and Natural Gas Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	83939.32	94936.26	94936.26	104815.43	104815.43	121620.31	121620.3	126780.94	126780.9	137101.73	137101.7	139762.95	139763	155011.99	155012
Add : Non Current Investments	5182.74	4364.34	4006.46	9173.05	7879.65	17204.31	14038.72	18124.28	14608.17	20290.74	16983.35	50515.42	41574.19	85730.80	68498.91
Add: Long Term Loans and Advances	32109.36	34632.38	31792.52	32305.97	27750.83	29488.52	24062.63	32015.20	25804.25	31068.61	26004.43	26263.93	21615.21	28235.70	22560.32
Add: Other Non Current Assets	862.43	1210.21	1110.97	1405.35	1207.20	1131.99	923.70	996.20	802.94	920.35	770.33	799.91	658.33	733.13	585.77
Add: Current Assets	25923.56	36584.41	33584.49	30426.87	26136.68	29843.30	24352.13	30163.26	24311.59	30724.34	25716.27	29907.28	24613.69	21516.56	17191.73
Total	148017.41	171727.60	165430.71	178126.67	167789.79	199288.43	184997.50	208079.88	192307.89	220105.77	206576.11	247249.49	228224.37	291228.18	263848.73
Less: Current Liabilities	19156.61	25697.95	23590.72	17473.85	15010.04	19079.76	15569.08	20318.58	16376.78	21142.23	17696.05	19233.46	15829.14	49361.86	39440.13
Net Capital Employed	128860.80	146029.65	141839.99	160652.82	152779.75	180208.67	169428.41	187761.30	175931.11	198963.54	188880.06	228016.03	212395.23	241866.32	224408.60
Less: Half of Profit (PAT)	9462.015	12561.46	12561.46	10462.85	10462.85	11047.41	11047.41	8866.475	8866.475	8001.825	8001.825	8949.99	8949.99	9972.63	9972.63
Average Investment	119398.79	133468.19	129278.53	150189.97	142316.90	169161.27	158381.01	178894.83	167064.64	190961.72	180878.24	219066.04	203445.24	231893.69	214435.97
Normal Investor Input @ 16.04 % Base Year Industry Standard	19151.57		20736.28		22827.63		25404.31		26797.17		29012.87		32632.62		34395.53

Appendix 7.8

Revaluation of Average Investment and Normal Investor Input of Power Grid Corporation of India Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	50187.66	63235.80	63235.80	80515.56	80515.56	105005.48	105005.48	129568.40	129568.40	149108.59	149108.59	171392.12	171392.12	183917.50	183917.50
Add : Non Current Investments	1214.01	1101.19	1010.89	964.24	828.28	814.33	664.49	740.99	597.24	771.28	645.56	1327.55	1092.57	1608.24	1284.98
Add: Long Term Loans and Advances	3615.33	5614.76	5154.35	6129.76	5265.46	4552.99	3715.24	4177.89	3367.38	4838.56	4049.87	4455.36	3666.76	9119.47	7286.46
Add: Other Non Current Assets	11078.22	13926.71	12784.72	17424.91	14968.00	20115.87	16414.55	15883.50	12802.10	13728.69	11490.91	6454.38	5311.95	5960.34	4762.31
Add: Current Assets	9626.35	8337.62	7653.94	6099.09	5239.12	9100.40	7425.93	7930.10	6391.66	9981.80	8354.77	11050.05	9094.19	12300.20	9827.86
Total	75721.57	92216.08	89839.70	111133.56	106816.42	139589.07	133225.69	158300.88	152726.78	178428.92	173649.71	194679.46	190557.60	212905.75	207079.11
Less: Current Liabilities	10512.94	13378.74	12281.68	14708.50	12634.60	19517.13	15925.98	21864.52	17622.80	25253.57	21137.24	24759.13	20376.76	26899.93	21493.04
Net Capital Employed	65208.63	78837.34	77558.01	96425.06	94181.82	120071.94	117299.71	136436.36	135103.98	153175.35	152512.47	169920.33	170180.84	186005.82	185586.07
Less: Half of Profit (PAT)	1348.45	1627.48	1627.48	2117.25	2117.25	2248.71	2248.71	2489.59	2489.59	3013.36	3013.36	3760.08	3760.08	4119.48	4119.48
Average Investment	63860.19	77209.87	75930.54	94307.81	92064.57	117823.23	115051.00	133946.78	132614.39	150161.99	149499.11	166160.26	166420.76	181886.34	181466.59
Normal Investor Input @ 16.04 % Base Year Industry Standard	10243.17		12179.26		14767.16		18454.18		21271.35		23979.66		26693.89		29107.24

Appendix 7.9 to 7.12. Revaluation of Average Investment and Normal Investor Input of Information Technology Sector Companies

Appendix 7.9

Revaluation of Average Investment and Normal Investor Input of Infosys Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	4305.00	4649.00	4649.00	5588.00	5588.00	6686.00	6686.00	8116.00	8116.00	9182.00	9182.00	9852.00	9852.00	10599.00	10599.00
Add : Non Current Investments	1206.00	1068.00	980.42	2764.00	2374.28	3968.00	3237.89	6108.00	4923.05	11111.00	9299.91	15334.00	12619.88	11993.00	9582.41
Add: Long Term Loans and Advances	1474.00	1620.00	1487.16	1907.00	1638.11	2769.00	2259.50	4811.00	3877.67	6375.00	5335.88	6021.00	4955.28	7034.00	5620.17
Add: Other Non Current Assets	0.00	13.00	11.93	31.00	26.63	52.00	42.43	26.00	20.96	2.00	1.67	996.00	819.71	2161.00	1726.64
Add: Current Assets	21869.00	28465.00	26130.87	32738.00	28121.94	39237.00	32017.39	42752.00	34458.11	46097.00	38583.19	47682.00	39242.29	44090.00	35227.91
Total	28854.00	35815.00	33259.39	43028.00	37748.96	52712.00	44243.22	61813.00	51395.78	72767.00	62402.65	79885.00	67489.16	75877.00	62756.12
Less: Current Liabilities	4328.00	6037.00	5541.97	6793.00	5835.19	10256.00	8368.90	13715.00	11054.29	15537.00	13004.47	11786.00	9699.88	11662.00	9317.94
Net Capital Employed	24526.00	29778.00	27717.42	36235.00	31913.77	42456.00	35874.32	48098.00	40341.49	57230.00	49398.18	68099.00	57789.28	64215.00	53438.18
Less: Half of Profit (PAT)	3221.50	4235.00	4235.00	4558.00	4558.00	5097.00	5097.00	6082.00	6082.00	7893.00	7893.00	6909.00	6909.00	8077.50	8077.50
Average Investment	21304.50	25543.00	23482.42	31677.00	27355.77	37359.00	30777.32	42016.00	34259.49	49337.00	41505.18	61190.00	50880.28	56137.50	45360.68
Normal Investor Input @ 38.48% Base Year Industry Standard	8197.97		9036.04		10526.50		11843.11		13183.05		15971.19		19578.73		17454.79

Appendix 7.10

Revaluation of Average Investment and Normal Investor Input of Tata Consultancy Services Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	4495.04	5463.44	5463.44	6868.13	6868.13	8976.72	8976.72	10703.23	10703.23	11355.12	11355.12	10708.00	10708.00	10678.00	10678.00
Add : Non Current Investments	5457.91	5150.15	4727.84	5975.73	5133.15	5098.55	4160.42	2651.23	2136.89	2228.28	1865.07	2201.00	1811.42	2186.00	1746.61
Add: Long Term Loans and Advances	2916.12	4472.55	4105.80	4778.44	4104.68	7149.12	5833.68	8756.02	7057.35	10216.75	8551.42	7828.00	6442.44	9155.00	7314.85
Add: Other Non Current Assets	2603.26	2636.88	2420.66	1881.20	1615.95	1544.99	1260.71	524.68	422.89	572.52	479.20	579.00	476.52	815.00	651.19
Add: Current Assets	10570.48	16535.79	15179.86	23330.54	20040.93	34834.81	28425.20	40430.14	32586.69	53295.87	44608.64	68442.00	56327.77	68222.00	54509.38
Total	26042.81	34258.81	31897.59	42834.04	37762.85	57604.19	48656.74	63065.30	52907.06	77668.54	66859.45	89758.00	75766.15	91056.00	74900.02
Less: Current Liabilities	6151.59	8835.48	8110.97	9498.81	8159.48	12265.70	10008.81	16463.63	13269.69	17706.29	14820.16	10701.00	8806.92	14058.00	11232.34
Net Capital Employed	19891.22	25423.33	23786.62	33335.23	29603.37	45338.49	38647.92	46601.67	39637.37	59962.25	52039.29	79057.00	66959.23	76998.00	63667.68
Less: Half of Profit (PAT)	3785.00	5487.99	5037.97	6393.17	5491.73	9237.46	7537.77	9628.48	7760.55	11441.35	9576.41	11826.50	9733.21	12620.50	10083.78
Average Investment	16106.23	19935.34	18748.64	26942.06	24111.64	36101.03	31110.16	36973.19	31876.82	48520.90	42462.88	67230.50	57226.02	64377.50	53583.90
Normal Investor Input @ 38.48% Base Year Industry Standard	6197.68		7214.48		9278.16		11971.19		12266.20		16339.72		22020.57		20619.08

Appendix 7.11

Revaluation of Average Investment and Normal Investor Input of Tech Mahindra Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	660.80	815.30	815.30	748.50	748.50	2097.60	2097.60	2532.10	2532.10	2907.20	2907.20	2860.00	2860.00	3465.80	3465.80
Add : Non Current Investments	3114.90	3133.10	2876.19	3807.50	3270.64	2294.00	1871.90	3630.90	2926.51	3796.30	3177.50	5747.60	4730.27	6865.00	5485.14
Add: Long Term Loans and Advances	410.30	334.10	306.70	449.60	386.21	940.60	767.53	1076.50	867.66	1260.60	1055.12	1483.10	1220.59	1470.60	1175.01
Add: Other Non Current Assets	53.20	82.00	75.28	94.40	81.09	326.60	266.51	288.10	232.21	412.20	345.01	513.20	422.36	656.70	524.70
Add: Current Assets	1841.20	1980.90	1818.47	2158.50	1854.15	9080.40	7409.61	9488.90	7648.05	12273.60	10273.00	13128.90	10805.08	14340.70	11458.22
Total	6080.40	6345.40	5891.93	7258.50	6340.59	14739.20	12413.15	17016.50	14206.53	20649.90	17757.84	23732.80	20038.31	26798.80	22108.87
Less: Current Liabilities	1529.50	1700.70	1561.24	2379.50	2043.99	4219.30	3442.95	4200.70	3385.76	5348.40	4476.61	4694.90	3863.90	5025.70	4015.53
Net Capital Employed	4550.90	4644.70	4330.69	4879.00	4296.60	10519.90	8970.20	12815.80	10820.76	15301.50	13281.23	19037.90	16174.41	21773.10	18093.33
Less: Half of Profit (PAT)	348.35	230.30	211.42	326.25	280.25	1342.75	1095.68	1128.10	909.25	1610.00	1347.57	1523.65	1253.96	1999.65	1597.72
Average Investment	4202.55	4414.40	4119.27	4552.75	4016.35	9177.15	7874.51	11687.70	9911.51	13691.50	11933.66	17514.25	14920.45	19773.45	16495.61
Normal Investor Input @ 38.48% Base Year Industry Standard	1617.14		1585.10		1545.49		3030.11		3813.95		4592.07		5741.39		6347.51

Appendix 7.12

Revaluation of Average Investment and Normal Investor Input of Wipro Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	4633.40	4951.00	4951.00	4288.30	4288.30	4250.10	4250.10	4399.60	4399.60	4513.80	4513.80	5056.30	5056.30	5657.60	5657.60
Add : Non Current Investments	6018.40	6294.30	5778.17	4854.70	4170.19	5196.80	4240.59	5579.70	4497.24	5732.80	4798.35	6010.00	4946.23	5845.70	4670.71
Add: Long Term Loans and Advances	962.70	940.40	863.29	2516.80	2161.93	2998.10	2446.45	3071.00	2475.23	3358.40	2810.98	1955.10	1609.05	2587.30	2067.25
Add: Other Non Current Assets	793.10	952.00	873.94	662.00	568.66	687.70	561.16	502.70	405.18	542.80	454.32	1408.40	1159.11	1613.40	1289.11
Add: Current Assets	21712.20	25458.20	23370.63	28384.80	24382.54	32604.20	26605.03	39855.50	32123.53	45028.70	37689.02	48727.10	40102.40	42967.30	34330.87
Total	34119.80	38595.90	35837.02	40706.60	35571.62	45736.90	38103.33	53408.50	43900.77	59176.50	50266.48	63156.90	52873.09	58671.30	48015.55
Less: Current Liabilities	10324.60	11740.60	10777.87	16124.60	13851.03	14915.60	12171.13	17365.30	13996.43	16607.10	13900.14	13839.90	11390.24	15035.90	12013.68
Net Capital Employed	23795.20	26855.30	25059.15	24582.00	21720.59	30821.30	25932.20	36043.20	29904.34	42569.40	36366.34	49317.00	41482.86	43635.40	36001.86
Less: Half of Profit (PAT)	2421.85	2342.55	2150.46	2825.10	2426.76	3693.70	3014.06	4096.55	3301.82	4049.50	3389.43	4080.85	3358.54	3861.40	3085.26
Average Investment	21373.35	24512.75	22908.69	21756.90	19293.83	27127.60	22918.14	31946.65	26602.52	38519.90	32976.91	45236.15	38124.32	39774.00	32916.60
Normal Investor Input @ 38.48% Base Year Industry Standard	8224.47		8815.26		7424.26		8818.90		10236.65		12689.51		14670.24		12666.31

Appendix 7.13 to 7.16 Revaluation of Average Investment and Normal Investor Input of Metals Sector Companies

Appendix 7.13

Revaluation of Average Investment and Normal Investor Input of Coal India Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	154.43	174.31	174.31	218.52	218.52	299.98	299.98	326.77	326.77	336.03	336.03	334.85	334.85	435.88	435.88
Add : Non Current Investments	6319.17	6319.19	5801.02	8858.19	7609.19	8858.19	7228.28	10909.16	8792.78	10909.24	9131.03	11529.07	9488.42	12137.39	9697.77
Add: Long Term Loans and Advances	3171.51	3138.12	2880.79	1815.75	1559.73	667.70	544.84	135.82	109.47	157.83	132.10	3301.66	2717.27	3676.86	2937.81
Add: Other Non Current Assets	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2592.39	2089.47	3080.51	2578.39	98.83	81.34	62.21	49.71
Add: Current Assets	18030.87	21080.58	19351.97	23144.66	19881.26	15215.72	12416.03	8185.70	6597.67	6378.17	5338.53	3620.99	2980.07	2152.58	1719.91
Total	27675.98	30712.20	28208.09	34037.12	29268.70	25041.59	20489.13	22149.84	17916.16	20861.78	17516.08	18885.40	15601.95	18464.92	14841.08
Less: Current Liabilities	6909.22	7855.12	7211.00	10138.81	8709.24	5888.97	4805.40	2321.31	1870.98	1978.93	1656.36	1305.47	1074.40	1832.58	1464.23
Net Capital Employed	20766.76	22857.08	20997.09	23898.31	20559.46	19152.62	15683.73	19828.53	16045.19	18882.85	15859.72	17579.93	14527.55	16632.34	13376.85
Less: Half of Profit (PAT)	2348.05	4032.55	3701.88	4897.16	4206.66	7504.27	6123.48	6691.70	5393.51	8171.77	6839.77	7250.27	5966.97	4646.71	3712.72
Average Investment	18418.71	18824.53	17295.21	19001.15	16352.80	11648.35	9560.25	13136.84	10651.68	10711.09	9019.95	10329.67	8560.58	11985.63	9664.13
Normal Investor Input @15.86% Base Year Industry Standard	2921.21		2743.02		2593.55		1516.26		1689.36		1430.56		1357.71		1532.73

Appendix 7.14

Revaluation of Average Investment and Normal Investor Input of Hindalco Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	13614.79	23407.14	23407.14	30702.77	30702.77	35331.94	35331.94	36803.52	36803.52	35897.08	35897.08	35095.83	35095.83	35100.89	35100.89
Add : Non Current Investments	13049.66	13503.70	12396.40	14050.17	12069.10	15312.45	12494.96	14781.75	11914.09	14797.33	12385.37	20479.17	16854.36	23249.67	18576.49
Add: Long Term Loans and Advances	3942.59	2249.53	2065.07	1681.08	1444.05	1161.15	947.50	1454.73	1172.51	1200.08	1004.47	2001.15	1646.95	1560.21	1246.61
Add: Other Non Current Assets	0.10	7.81	7.17	34.51	29.64	12.52	10.22	31.44	25.34	80.08	67.03	724.02	595.87	861.49	688.33
Add: Current Assets	15929.20	16479.44	15128.13	20150.03	17308.88	21951.89	17912.74	22929.20	18480.94	24152.12	20215.32	28334.77	23319.52	21956.62	17543.34
Total	46536.34	55647.62	53003.90	66618.56	61554.43	73769.95	66697.36	76000.64	68396.40	76126.69	69569.26	86634.94	77512.52	82728.88	73155.65
Less: Current Liabilities	9842.64	10035.04	9212.17	9736.76	8363.88	12581.79	10266.74	13092.72	10552.73	12351.71	10338.38	18700.77	15390.73	12949.66	10346.78
Net Capital Employed	36693.70	45612.58	43791.73	56881.80	53190.56	61188.16	56430.62	62907.92	57843.67	63774.98	59230.88	67934.17	62121.78	69779.22	62808.88
Less: Half of Profit (PAT)	1068.46	1118.60	1026.87	849.60	729.81	706.67	576.64	462.58	372.84	303.63	254.13	778.44	640.66	718.25	573.88
Average Investment	35625.24	44493.98	42764.86	56032.20	52460.75	60481.50	55853.98	62445.34	57470.83	63471.36	58976.75	67155.73	61481.12	69060.98	62235.00
Normal Investor Input @15.86% Base Year Industry Standard	5650.16		6782.51		8320.28		8858.44		9114.87		9353.71		9750.91		9870.47

Appendix 7.15

Revaluation of Average Investment and Normal Investor Input of Tata Steel Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	17417.38	27424.75	27424.75	33597.34	33597.34	42775.15	42775.15	48285.19	48285.19	52410.96	52410.96	78731.11	78731.11	77402.35	77402.35
Add : Non Current Investments	43565.15	49078.35	45053.93	49984.80	42936.94	52318.56	42691.94	52164.24	42044.38	52360.42	43825.67	8355.90	6876.91	9636.56	7699.61
Add: Long Term Loans and Advances	10453.41	6820.70	6261.40	6574.15	5647.19	4080.07	3329.34	3207.90	2585.57	3787.88	3170.46	1159.33	954.13	1290.68	1031.25
Add: Other Non Current Assets	2.76	2.76	2.53	215.79	185.36	302.03	246.46	211.75	170.67	227.40	190.33	3108.67	2558.44	2140.84	1710.53
Add: Current Assets	18113.02	12864.50	11809.61	11504.85	9882.67	11564.60	9436.71	11994.56	9667.62	14421.49	12070.79	20110.40	16550.86	34643.91	27680.48
Total	89551.72	96191.06	90552.22	101876.93	92249.51	111040.41	98479.60	115863.64	102753.42	123208.15	111668.21	111465.41	105671.44	125114.34	115524.23
Less: Current Liabilities	13095.89	16903.64	15517.54	16488.65	14163.75	18881.78	15407.53	16769.18	13515.96	21087.99	17650.65	23056.33	18975.36	25607.34	20460.26
Net Capital Employed	76455.83	79287.42	75034.68	85388.28	78085.76	92158.63	83072.07	99094.46	89237.46	102120.16	94017.56	88409.08	86696.08	99507.00	95063.97
Less: Half of Profit (PAT)	3432.85	3348.21	3073.66	2531.49	2174.55	3206.10	2616.17	3219.56	2594.97	2450.47	2051.05	1722.28	1417.43	2084.78	1665.74
Average Investment	73022.99	75939.21	71961.02	82856.80	75911.21	88952.54	80455.90	95874.90	86642.50	99669.69	91966.51	86686.81	85278.65	97422.23	93398.23
Normal Investor Input @15.86% Base Year Industry Standard	11581.45		11413.02		12039.52		12760.31		13741.50		14585.89		13525.19		14812.96

Appendix 7.16

Revaluation of Average Investment and Normal Investor Input of Vedanta Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	1264.41	1673.99	1673.99	1917.89	1917.89	39911.36	39911.36	39548.02	39548.02	44246.20	44246.20	53440.00	53440.00	55545.00	55545.00
Add : Non Current Investments	1713.27	14224.87	13058.43	14565.86	12512.07	22419.11	18293.99	26088.30	21027.17	31762.29	26585.04	66417.00	54661.19	62473.00	49915.93
Add: Long Term Loans and Advances	152.98	141.25	129.67	454.89	390.75	9905.52	8082.90	3319.22	2675.29	3421.28	2863.61	5086.00	4185.78	3343.00	2671.06
Add: Other Non Current Assets	0.00	0.00	0.00	0.00	0.00	104.40	85.19	70.39	56.73	63.15	52.86	1863.00	1533.25	2577.00	2059.02
Add: Current Assets	11067.12	1797.99	1650.55	1496.67	1285.64	11149.29	9097.82	9508.47	7663.83	16486.31	13799.04	39378.00	32408.09	23231.00	18561.57
Total	14197.78	17838.10	16512.64	18435.31	16106.35	83489.68	75471.27	78534.40	70971.04	95979.23	87546.75	166184.00	146228.31	147169.00	128752.58
Less: Current Liabilities	1496.02	3723.16	3417.86	4217.83	3623.12	28881.05	23566.94	22501.50	18136.21	27554.91	23063.46	57611.00	47413.85	49645.00	39666.36
Net Capital Employed	12701.76	14114.94	13094.78	14217.48	12483.24	54608.63	51904.33	56032.90	52834.83	68424.32	64483.29	108573.00	98814.46	97524.00	89086.22
Less: Half of Profit (PAT)	1716.40	839.97	771.09	60.38	51.87	538.04	439.04	963.60	776.66	2735.94	2289.98	5534.50	4554.89	3628.00	2898.77
Average Investment	10985.36	13274.97	12323.69	14157.10	12431.37	54070.59	51465.29	55069.30	52058.17	65688.38	62193.30	103038.50	94259.57	93896.00	86187.45
Normal Investor Input @ 15.86% Base Year Industry Standard	1742.28		1954.54		1971.61		8162.39		8256.43		9863.86		14949.57		13669.33

Appendix 7.17 to 7.20 Revaluation of Average Investment and Normal Investor Input of Pharmaceutical Sector Companies

Appendix 7.17

Revaluation of Average Investment and Normal Investor Input of Cipla Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	3120.72	3346.11	3346.11	3768.63	3768.63	3900.88	3900.88	3954.33	3954.33	4396.94	4396.94	4791.35	4791.35	4782.95	4782.95
Add : Non Current Investments	347.06	461.83	423.96	514.36	441.84	3328.28	2715.88	4036.99	3253.81	4317.81	3614.01	3647.71	3002.07	3597.24	2874.19
Add: Long Term Loans and Advances	435.50	385.65	354.03	373.72	321.03	535.30	436.80	576.71	464.83	772.61	646.67	524.61	431.75	604.21	482.76
Add: Other Non Current Assets	0.15	0.24	0.22	61.57	52.89	61.57	50.24	65.29	52.62	68.20	57.08	298.21	245.43	172.40	137.75
Add: Current Assets	4544.40	4799.96	4406.36	6774.93	5819.66	5097.97	4159.94	6558.50	5286.15	6463.90	5410.28	6345.34	5222.21	7938.17	6342.60
Total	8447.83	8993.79	8530.68	11493.21	10404.04	12924.00	11263.75	15191.82	13011.75	16019.46	14124.99	15607.22	13692.81	17094.97	14620.25
Less: Current Liabilities	1598.51	1179.74	1083.00	2264.60	1945.29	2416.74	1972.06	3566.26	2874.41	3081.20	2578.96	2555.83	2103.45	2731.70	2182.63
Net Capital Employed	6849.32	7814.05	7447.68	9228.61	8458.75	10507.26	9291.69	11625.56	10137.34	12938.26	11546.02	13051.39	11589.36	14363.27	12437.63
Less: Half of Profit (PAT)	480.20	561.98	515.90	753.56	647.30	694.17	566.44	590.55	475.98	699.01	585.08	487.47	401.19	734.26	586.67
Average Investment	6369.13	7252.07	6931.78	8475.06	7811.45	9813.09	8725.24	11035.02	9661.36	12239.25	10960.95	12563.92	11188.18	13629.01	11850.95
Normal Investor Input @18.85% Base Year Industry Standard	1200.58		1306.64		1472.46		1644.71		1821.17		2066.14		2108.97		2233.90

Appendix 7.18

Revaluation of Average Investment and Normal Investor Input of Dr. Reddy Laboratories Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	2237.00	2514.40	2514.40	2810.20	2810.20	3324.40	3324.40	3737.70	3737.70	5044.30	5044.30	5382.10	5382.10	5392.30	5392.30
Add : Non Current Investments	2462.00	2270.70	2084.50	2182.60	1874.85	1740.10	1419.92	1760.10	1418.64	1776.10	1486.60	1802.80	1483.70	1953.70	1561.01
Add: Long Term Loans and Advan	911.70	631.80	579.99	375.20	322.30	535.80	437.21	553.80	446.36	639.60	535.35	631.30	519.56	704.60	562.98
Add: Other Non Current Assets	0.00	0.00	0.00	20.90	17.95	0.00	0.00	1.10	0.89	2.70	2.26	37.20	30.62	11.20	8.95
Add: Current Assets	3652.70	4923.70	4519.96	6600.20	5669.57	8907.80	7268.76	10403.30	8385.06	10094.90	8449.43	8593.80	7072.70	9038.50	7221.76
Total	9263.40	10340.60	9698.85	11989.10	10694.88	14508.10	12450.30	16456.00	13988.65	17557.60	15517.93	16447.20	14488.68	17100.30	14746.99
Less: Current Liabilities	2603.70	3062.30	2811.19	4073.10	3498.79	4114.20	3357.19	4678.60	3770.95	4798.70	4016.51	4258.00	3504.33	4719.90	3771.20
Net Capital Employed	6659.70	7278.30	6887.66	7916.00	7196.08	10393.90	9093.11	11777.40	10217.70	12758.90	11501.42	12189.20	10984.34	12380.40	10975.79
Less: Half of Profit (PAT)	446.70	456.20	418.79	632.75	543.53	966.40	788.58	839.70	676.80	677.25	566.86	692.05	569.56	283.45	226.48
Average Investment	6213.00	6822.10	6468.87	7283.25	6652.55	9427.50	8304.53	10937.70	9540.90	12081.65	10934.56	11497.15	10414.79	12096.95	10749.32
Normal Investor Input @18.85% Base Year Industry Standard	1171.15		1219.38		1254.01		1565.40		1798.46		2061.16		1963.19		2026.25

Appendix 7.19

Revaluation of Average Investment and Normal Investor Input of Lupin Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	1796.72	2064.81	2064.81	2253.77	2253.77	2446.51	2446.51	2525.56	2525.56	2969.18	2969.18	3493.28	3493.28	4511.70	4511.70
Add : Non Current Investments	680.88	687.29	630.93	688.04	591.03	989.05	807.06	1790.26	1442.95	3740.82	3131.07	4801.92	3951.98	5130.26	4099.08
Add: Long Term Loans and Advances	307.05	380.51	349.31	362.03	310.98	319.70	260.88	239.45	193.00	271.57	227.30	85.53	70.39	208.44	166.54
Add: Other Non Current Assets	4.52	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.26	0.00	0.00	216.74	178.38	113.15	90.41
Add: Current Assets	2422.60	3026.10	2777.96	3741.89	3214.28	5043.70	4115.66	6452.12	5200.41	7235.33	6055.97	9250.77	7613.38	8717.45	6965.24
Total	5211.77	6158.71	5823.01	7045.73	6370.06	8798.96	7630.11	11007.71	9362.17	14216.90	12383.52	17848.24	15307.41	18681.00	15832.97
Less: Current Liabilities	1594.85	2035.66	1868.74	1857.15	1595.29	1461.32	1192.44	1659.99	1337.95	2293.55	1919.70	2565.61	2111.50	2336.21	1866.63
Net Capital Employed	3616.92	4123.05	3954.27	5188.58	4774.77	7337.64	6437.67	9347.72	8024.22	11923.35	10463.82	15282.63	13195.92	16344.79	13966.34
Less: Half of Profit (PAT)	404.99	402.19	369.21	630.22	541.35	1162.11	948.28	1198.68	966.13	1442.54	1207.40	1570.67	1292.66	672.33	537.19
Average Investment	3211.93	3720.87	3585.07	4558.37	4233.42	6175.53	5489.39	8149.05	7058.09	10480.82	9256.42	13711.97	11903.26	15672.46	13429.15
Normal Investor Input @18.85% Base Year Industry Standard	605.45		675.79		798.00		1034.75		1330.45		1744.83		2243.76		2531.39

Appendix 7.20

Revaluation of Average Investment and Normal Investor Input of Sun Pharmaceutical Industries Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	990.04	1226.17	1226.17	1483.83	1483.83	1747.63	1747.63	4275.86	4275.86	4335.90	4335.90	5139.13	5139.13	5432.66	5432.66
Add : Non Current Investments	1778.59	3592.80	3298.19	3376.49	2900.40	6155.73	5023.08	25782.23	20780.48	22283.11	18650.96	19293.29	15878.38	18310.50	14630.09
Add: Long Term Loans and Advances	143.89	338.54	310.78	491.09	421.85	761.49	621.38	1895.23	1527.56	2165.47	1812.50	2637.86	2170.96	2878.33	2299.79
Add: Other Non Current Assets	0.19	2.83	2.60	7.83	6.73	0.11	0.09	41.95	33.81	61.75	51.68	410.80	338.09	395.36	315.89
Add: Current Assets	4693.89	3970.86	3645.25	3887.25	3339.15	5172.04	4220.38	5450.28	4392.93	5343.70	4472.68	6388.19	5257.48	6907.52	5519.11
Total	7606.60	9131.20	8482.99	9246.49	8151.95	13837.00	11612.56	37445.55	31010.63	34189.93	29323.72	33869.27	28784.04	33924.37	28197.54
Less: Current Liabilities	786.69	1018.52	935.00	1155.06	992.20	3706.07	3024.15	11052.08	8907.98	8838.78	7398.06	10962.65	9022.26	12243.49	9782.55
Net Capital Employed	6819.91	8112.68	7547.99	8091.43	7159.76	10130.93	8588.40	26393.47	22102.65	25351.15	21925.66	22906.62	19761.77	21680.88	18414.99
Less: Half of Profit (PAT)	691.90	848.75	779.15	258.28	221.86	-1414.26	-1154.04	-737.07	-594.07	-536.68	-449.20	-11.42	-9.40	-247.30	-197.59
Average Investment	6128.01	7263.94	6768.84	7833.16	6937.90	11545.19	9742.44	27130.54	22696.73	25887.83	22374.87	22918.04	19771.17	21928.18	18612.58
Normal Investor Input @ 18.85% Base Year Industry Standard	1155.13		1275.93		1307.79		1836.45		4278.33		4217.66		3726.87		3508.47

Appendix 7.21 to 7.24 Revaluation of Average Investment and Normal Investor Input of Refineries Sector Companies

Appendix 7.21

Revaluation of Average Investment and Normal Investor Input of Bharat Petroleum Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	16971.72	17731.44	17731.44	19110.15	19110.15	22104.61	22104.61	27980.74	27980.74	36085.72	36085.72	43059.83	43059.83	47385.43	47385.43
Add : Non Current Investments	4945.68	4970.29	4562.73	6942.10	5963.26	7238.10	5906.29	7302.05	5885.45	7875.58	6591.86	9241.11	7605.43	10825.40	8649.49
Add: Long Term Loans and Advances	3166.62	3458.97	3175.33	2512.04	2157.84	3266.66	2665.59	4077.17	3286.20	3864.84	3234.87	3945.57	3247.20	3542.02	2830.07
Add: Other Non Current Assets	0.94	0.95	0.87	27.65	23.75	166.14	135.57	83.46	67.27	87.70	73.40	1485.00	1222.16	1571.28	1255.45
Add: Current Assets	30790.99	39445.33	36210.81	38379.59	32968.07	39651.90	32355.95	30301.09	24422.68	28075.57	23499.25	34258.12	28194.43	36898.41	29481.83
Total	55875.95	65606.98	61681.19	66971.53	60223.08	72427.41	63168.01	69744.51	61642.34	75989.41	69485.11	91989.63	83329.06	100222.54	89602.28
Less: Current Liabilities	37387.96	46667.55	42840.81	42020.59	36095.69	38581.34	31482.37	32653.13	26318.42	31698.56	26531.69	43489.26	35791.66	44792.11	35788.90
Net Capital Employed	18487.99	18939.43	18840.37	24950.94	24127.39	33846.07	31685.64	37091.38	35323.92	44290.85	42953.41	48500.37	47537.39	55430.43	53813.39
Less: Half of Profit (PAT)	773.34	655.64	601.87	1321.45	1135.13	2030.44	1656.84	2542.26	2049.06	3715.94	3110.24	4019.65	3308.17	3959.67	3163.78
Average Investment	17714.65	18283.80	18238.50	23629.49	22992.26	31815.63	30028.80	34549.13	33274.86	40574.91	39843.17	44480.72	44229.22	51470.76	50649.61
Normal Investor Input @ 5.55% Base Year Industry Standard	983.16		1012.24		1276.07		1666.60		1846.75		2211.30		2454.72		2811.05

Appendix 7.22

Revaluation of Average Investment and Normal Investor Input of Hindustan Petroleum Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	22340.53	25294.12	25294.12	27721.57	27721.57	30497.80	30497.80	32537.23	32537.23	35322.71	35322.71	37942.36	37942.36	41957.10	41957.10
Add : Non Current Investments	7324.33	7483.43	6869.79	8266.07	7100.55	5735.83	4680.44	5867.52	4729.22	6000.06	5022.05	5809.86	4781.51	6105.72	4878.47
Add: Long Term Loans and Advances	1275.46	1502.60	1379.39	1937.70	1664.48	1461.42	1192.52	1429.86	1152.47	1573.40	1316.94	456.43	375.64	461.61	368.83
Add: Other Non Current Assets	227.56	67.46	61.93	88.75	76.24	146.26	119.35	116.55	93.94	86.03	72.01	1338.88	1101.90	1409.08	1125.85
Add: Current Assets	29593.21	36759.74	33745.44	38230.64	32840.12	39736.78	32425.21	27599.48	22245.18	27488.73	23008.07	32922.32	27095.07	36873.71	29462.09
Total	60761.09	71107.35	67350.67	76244.73	69402.96	77578.09	68915.32	67550.64	60758.04	70470.93	64741.77	78469.85	71296.48	86807.22	77792.35
Less: Current Liabilities	34714.81	42700.36	39198.93	43262.65	37162.62	35307.26	28810.72	23701.04	19103.04	26789.04	22422.43	45758.27	37659.06	47377.35	37854.50
Net Capital Employed	26046.28	28406.99	28151.73	32982.08	32240.35	42270.83	40104.59	43849.60	41655.00	43681.89	42319.34	32711.58	33637.43	39429.87	39937.84
Less: Half of Profit (PAT)	769.51	455.71	418.35	452.36	388.57	866.89	707.38	1366.63	1101.50	1931.37	1616.56	3104.40	2554.92	3178.54	2539.65
Average Investment	25276.78	27951.28	27733.39	32529.73	31851.78	41403.95	39397.21	42482.97	40553.50	41750.52	40702.79	29607.18	31082.51	36251.34	37398.19
Normal Investor Input @ 5.55% Base Year Industry Standard	1402.86		1539.20		1767.77		2186.55		2250.72		2259.00		1725.08		2075.60

Appendix 7.23

Revaluation of Average Investment and Normal Investor Input of Indian Oil Corporation Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	67468.00	73554.10	73554.10	86863.05	86863.05	96828.02	96828.02	102574.97	102574.97	111917.72	111917.72	118617.31	118617.31	128275.75	128275.75
Add : Non Current Investments	4703.49	4918.01	4514.73	5032.62	4323.02	16311.49	13310.18	16628.58	13402.64	16964.26	14199.09	40109.19	33009.86	39088.94	31232.06
Add: Long Term Loans and Advances	4936.35	9643.80	8853.01	4876.23	4188.68	4626.48	3775.21	7740.89	6239.16	8303.53	6950.05	4557.93	3751.18	7086.90	5662.43
Add: Other Non Current Assets	3.99	17.01	15.62	13.86	11.91	70.02	57.14	94.56	76.22	71.93	60.21	3434.27	2826.40	3233.35	2583.45
Add: Current Assets	96567.85	121726.83	111745.23	131233.56	112729.63	134577.77	109815.46	92810.47	74805.24	89349.74	74785.73	92494.57	76123.03	103054.97	82340.92
Total	173679.68	209859.75	198682.69	228019.32	208116.29	252413.78	223786.00	219849.47	197098.22	226607.18	207912.80	259213.27	234327.79	280739.91	250094.61
Less: Current Liabilities	95223.50	129323.42	118718.90	128157.72	110087.48	135320.24	110421.32	94956.26	76534.75	98208.65	82200.64	128312.34	105601.06	135882.28	108569.94
Net Capital Employed	78456.18	80536.33	79963.79	99861.60	98028.80	117093.54	113364.68	124893.21	120563.47	128398.53	125712.16	130900.93	128726.73	144857.63	141524.67
Less: Half of Profit (PAT)	3722.74	1977.31	1815.17	2502.58	2149.72	3509.54	2863.79	2636.52	2125.03	5199.52	4351.99	9553.20	7862.28	10673.06	8527.77
Average Investment	74733.44	78559.02	78148.62	97359.02	95879.08	113584.00	110500.90	122256.70	118438.44	123199.02	121360.16	121347.73	120864.45	134184.57	132996.90
Normal Investor Input @ 5.55% Base Year Industry Standard	4147.71		4337.25		5321.29		6132.80		6573.33		6735.49		6707.98		7381.33

Appendix 7.24

Revaluation of Average Investment and Normal Investor Input of Reliance Industries Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
Items	Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
Fixed Assets	155526.03	121477.00	121477.00	128864.00	128864.00	151122.00	151122.00	190316.00	190316.00	238289.00	238289.00	287319.00	287319.00	300447.00	300447.00
Add : Non Current Investments	37651.54	26979.00	24766.72	24143.00	20738.84	52692.00	42996.67	62058.00	50018.75	112630.00	94271.31	140544.00	115667.71	171945.00	137384.06
Add: Long Term Loans and Advances	0.00	14340.00	13164.12	21528.00	18492.55	28436.00	23203.78	29259.00	23582.75	16237.00	13590.37	10418.00	8574.01	17699.00	14141.50
Add: Other Non Current Assets	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2184.00	1797.43	3522.00	2814.08
Add: Current Assets	91541.83	132344.00	121491.79	143976.00	123675.38	135333.00	110431.73	116152.00	93618.51	90564.00	75802.07	106281.00	87469.26	123912.00	99005.69
Total	284719.40	295140.00	280899.63	318511.00	291770.77	367583.00	327754.18	397785.00	357536.01	457720.00	421952.75	546746.00	500827.42	617525.00	553792.32
Less: Current Liabilities	54220.60	68888.00	63239.18	83286.00	71542.67	95566.00	77981.86	91301.00	73588.61	125022.00	104643.41	152826.00	125775.80	190647.00	152326.95
Net Capital Employed	230498.80	226252.00	217660.45	235225.00	220228.10	272017.00	249772.32	306484.00	283947.41	332698.00	317309.33	393920.00	375051.62	426878.00	401465.37
Less: Half of Profit (PAT)	10143.15	10020.00	9198.36	10501.50	9020.79	10992.00	8969.47	11359.50	9155.76	13708.50	11474.01	15712.50	12931.39	16806.00	13427.99
Average Investment	220355.65	216232.00	208462.09	224723.50	211207.31	261025.00	240802.85	295124.50	274791.65	318989.50	305835.32	378207.50	362120.24	410072.00	388037.38
Normal Investor Input @ 5.55% Base Year Industry Standard	12229.74		11569.65		11722.01		13364.56		15250.94		16973.86		20097.67		21536.07

Appendix 7.25 to 7.30. Calculation of Rate of Return

Appendix 7.25

Calculation of Rate of Return of Automobile Sector Companies in 2010-11 (Base Year)

S.No.	Particulars	1. Bajaj Auto Ltd.	2. Mahindra & Mahindra Ltd.	3. Maruti Suzuki India Ltd.	4. Tata Motors Ltd.
A	Output (Base Year) (A)	16891.95	23692.18	37071.20	47157.19
B	Total Cost (Base Year)				
1	Material	12175.39	16604.88	28490.10	35047.05
2	Labour	493.58	1431.52	703.60	2294.02
3	Overhead	763.67	2585.62	4855.70	6797.22
	Total (B)	13432.64	20622.02	34049.40	44138.29
	Base Year Returns (R = A-B)	3459.31	3070.16	3021.80	3018.90
	Average Investment (AI) (Base Year)	3722.20	12257.30	13262.10	34284.27
	Rate of Return (Company Standard) Rc =R/AI*100	92.94	25.05	22.79	8.81

Rate of Return of Automobile Sector Companies is 19.79%

Appendix 7.26

Calculation of Rate of Return of Energy Sector Companies in 2010-11 (Base Year)

S.No.	Particulars	1. GAIL (India) Ltd.	2. NTPC Ltd.	3. Oil and Natural Gas Corporation Ltd.	4. Power Grid Corporation of India Ltd.
A	Output (Base Year) (A)	32844.73	57407.30	71732.86	9098.75
B	Total Cost (Base Year)				
1	Material	23994.13	35405.11	2790.68	0.03
2	Labour	721.23	2789.71	6728.21	745.89
3	Overhead	3071.50	7380.64	34562.07	2898.29
	Total (B)	27786.86	45575.46	44080.96	3644.21
	Base Year Returns (R = A-B)	5057.87	11831.84	27651.90	5454.54
	Average Investment (AI) (Base Year)	21383.21	107146.55	119398.79	63860.19
	Rate of Return (Company Standard) Rc =R/AI*100	23.65	11.04	23.16	8.54

Rate of Return of Energy Sector Companies is 16.04%

Appendix 7.27

Calculation of Rate of Return of Information Technology Sector Companies in 2010-11 (Base Year)

S.No.	Particulars	1. Infosys Ltd.	2. Tata Consultancy Services Ltd.	3. Tech Mahindra Ltd.	4. Wipro Ltd.
A	Output (Base Year) (A)	26532.00	29771.01	5092.10	26949.60
B	Total Cost (Base Year)				
1	Material	482.00	17.75	1.50	3805.60
2	Labour	12459.00	10190.31	1943.80	10937.40
3	Overhead	4770.00	10840.77	2229.50	6428.30
	Total (B)	17711.00	21048.83	4174.80	21171.30
	Base Year Returns (R = A-B)	8821.00	8722.18	917.30	5778.30
	Average Investment (AI) (Base Year)	21304.50	16106.23	4202.55	21373.35
	Rate of Return (Company Standard) Rc =R/AI*100	41.40	54.15	21.83	27.04

Rate of Return of Information Technology Sector Companies is 38.48%

Appendix 7.28

Calculation of Rate of Return of Metals Sector Companies in 2010-11 (Base Year)

S.No.	Particulars	1. Coal India Ltd.	2. Hindalco Ltd.	3. Tata Steel Ltd.	4. Vedanta Ltd.
A	Output (Base Year) (A)	5473.42	23812.03	29751.06	7996.15
B	Total Cost (Base Year)				
1	Material	10.03	16435.73	7841.47	1178.32
2	Labour	251.11	1040.39	2837.46	149.08
3	Overhead	302.14	4310.55	8554.97	2221.06
	Total (B)	563.28	21786.67	19233.90	3548.46
	Base Year Returns (R = A-B)	4910.14	2025.36	10517.16	4447.69
	Average Investment (AI) (Base Year)	18418.71	35625.24	73022.99	10985.36
	Rate of Return (Company Standard) Rc =R/AI*100	26.66	5.69	14.40	40.49

Rate of Return of Metals Sector Companies is 15.86 %

Appendix 7.29

Calculation of Rate of Return of Pharmaceutical Sector Companies in 2010-11 (Base Year)

S.No.	Particulars	1. Cipla Ltd.	2. Dr. Reddy's Laboratories Ltd.	3. Lupin Ltd.	4. Sun Pharmaceutical Industries Ltd.
A	Output (Base Year) (A)	6308.14	5345.10	4510.95	3300.23
B	Total Cost (Base Year)				
1	Material	3085.90	1749.50	1921.18	928.85
2	Labour	464.20	701.20	491.23	214.06
3	Overhead	1852.99	1995.20	1228.24	699.95
	Total (B)	5403.09	4445.90	3640.65	1842.86
	Base Year Returns (R = A-B)	905.05	899.20	870.30	1457.37
	Average Investment (AI) (Base Year)	6369.13	6213.00	3211.93	6128.01
	Rate of Return (Company Standard) Rc =R/AI*100	14.21	14.47	27.10	23.78

Rate of Return of Pharmaceutical Sector Companies is 18.85 %

Appendix 7.30

Calculation of Rate of Return of Refineries Sector Companies in 2010-11 (Base Year)

S.No.	Particulars	1. Bharat Petroleum Corporation Ltd.	2. Hindustan Petroleum Corporation Ltd.	3. Indian Oil Corporation Ltd.	4. Reliance Industries Ltd.
A	Output (Base Year) (A)	151243.98	131403.00	326553.94	247978.66
B	Total Cost (Base Year)				
1	Material	141028.03	126018.95	299785.74	198076.21
2	Labour	2802.85	1981.84	6435.55	2624.17
3	Overhead	8011.77	7035.44	18436.42	26194.52
	Total (B)	151842.65	135036.23	324657.71	226894.90
	Base Year Returns (R = A-B)	-598.67	-3633.23	1896.23	21083.76
	Average Investment (AI) (Base Year)	17714.65	25276.78	74733.44	220355.65
	Rate of Return (Company Standard) Rc =R/AI*100	-3.38	-14.37	2.54	9.57

Rate of Return of Refineries Sector Companies is 5.55 %

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Chapter-8

Summary of Findings and Suggestions

CHAPTER 8

SUMMARY OF FINDINGS AND SUGGESTIONS

8.1. Chapter 1: Introduction

The idea of productivity is not new but in yester years it is getting more importance because it speeds up the process of quality production which ultimately results in economic development of the country and raises the living standard of the society, etc. It serves as the benchmark in ascertainment of efficiency of any type of organisation. The term Productivity and Efficiency seems synonyms, yet there is a slight difference between the two. The productivity of an organisation may be indicated without any improvement in its efficiency. On the other hand, the efficiency of an input may increase without any simultaneous improvement in its productivity.

Productivity can be measured wholly or partially. Productivity as a whole constitutes all the elements of partial productivity while partial productivity can be measured in terms of an element such as material productivity, labour productivity, overhead productivity, capital productivity, etc. It is the relationship between output and one or more of the inputs used in the production process. It is expressed as a ratio to reflect how efficiently resources are used in creating outputs.

Productivity, Production and Profitability are connected terms, yet there is difference between the three. Productivity is a measure of how efficiently resources are combined and utilised in the organisation for achieving the desired goals. Production is the function of an organisation which is associated with the conversion of range of inputs into desired outputs. Profitability is the financial measure for measuring the performance of an organisation. It is the money left over after meeting the expenses related to the production of a product. Thus the efficiency of an organisation in terms of production represents its productivity while wealth is generated in terms of profit denotes profitability.

The most integral purpose of the productivity analysis are comparing an enterprise with its competitors, determining the relative performance of the department and workers and comparing relative benefits of various types of inputs for collective bargaining and gain sharing.

- **Approaches for Measuring Productivity**

Different approaches for measuring productivity have been proposed and some of them are discussed below:

- *Index Number Approach*

This is the one of the commonly used approach for measuring the productivity of a concern. Laspeyres output quantity index (Q_O) and Laspeyres input quantity index (Q_I) is used for measuring productivity growth.

- *Parametric Estimation Approach*

Here, productivity is estimated through a cost function, where costs are expressed as a function of different outputs and the prices of each of the inputs.

- *Non-parametric Approach*

The focus of this approach is that it does not require information on weights to aggregate outputs (or inputs), so information on prices is not required. *Partial Efficiency Measure Approach*

In this approach a tradeoff is maintain between the output and the inputs and weights are assigned to them accordingly.

- **Productivity Measurement Models**

The various productivity measurement models are explained below:

- *Production Function Model*

  It considers production as the main function, so recognises only labour and capital as input, ignoring material and overhead input.

- *Economic Utility Model*

  Use of multi ratios have been recommended under this model. Under this, each ratio depends on a particular economic activity or a utility function.

- *Measurement through Financial Ratios*

  Under this approach, productivity is measured in accordance with the financial ratios. If these ratios are favourable then it indicates that the organisation is

more productive. If these ratios are not favourable then the organisation is considered to be less productive.

- *Surrogate Model*

  This model measures the productivity with the help of payroll records. It is the ratio of actual pay to the standard pay. Actual pay is the pay, paid to the worker or labour. Standard pay is the hours worked by worker or labour multiplied by the standard rate of pay.

- *Systems Approach Based Model*

  Productivity measurement presented by this model is based on the conventional methodologies and also output and input has been calculated by keeping in mind the traditional method.

- *Production Based Model*

  This model is divided into two major categories. According to that output is recognised as the value of production and the value addition and productivity is calculated accordingly.

- *Productivity Accounting Model (PAM)*

  This model analyses all possible outputs and inputs, keeping out external factors such as price rise, etc. from the calculation of productivity.

In the present research, Productivity Accounting Model has been used for measuring productivity because it considers all the elements of output and input, ignoring the effect of inflation. It is the model which helps the management in analysing areas of improvement, so that the proper and effective productivity techniques can be adopted and implemented.

- **Factors Affecting Productivity**

The factors which affect the productivity of an organisation will depend on its intensity to influence organisation's day to day affairs. Some of these are technological factors, financial factors, natural factors, social factors, human factors, government policies.

- **Productivity Improvement Techniques**

Productivity can be improved by adopting the techniques such as Work study, Research and Development, Incentive Schemes, Production Planning and Control, Workers Participation in Management, Automation, Management by Objectives,

Job Enrichment, Flexi time, Quality of Work Life (QWL) and Quality Circles (QC).

8.2. Chapter 2: Review of Literature

The main objectives behind the review of literature are as follows:

1. It surveys the literature on the area chosen for the research.
2. It critically analyse the information gathered by identifying the gaps in the present research.
3. It also considered as a base for the further research.

This chapter presents chronological review of literature and has been categorised into two parts according to the literature:

1. Reviews of International Level Literature
2. Reviews of National Level Literature

- **Reviews of International Level Literature**

Islam (1990) focused on the measurement and analysis of labour productivity with distinct reference to cotton textile industry in Bangladesh. The study is remarkable because there are certain marginal innovations in the methodology applied for measurements of variables while **Dias (1991)** analysed in their paper the two indexes of productivity, viz. labour productivity and capital productivity patterns of manufacturing industries in Sri Lanka. The investigation also stipulated that there is a considerable scope for increasing production in some districts in Sri Lanka.

Brynjolfsson (1993) explained in his article the relationship between information technology and productivity which indicates low IT capital productivity in a variety of manufacturing and service sector industries while **Bai and Li (2004)** examined the convergence process of industrial productivity in Chinese region. It is suggested that the government has to play an active role in promoting these regions and to give incentives to international firms to invest in these regions. **Peslak (2004)** aimed to find out information technology with a new data set from a European publish source and measure productivity using both market and financial based measure.

Schoer (2006) in his paper presented a technique for calculating the direct material input used in Raw Material Equivalents (RME). **Gilanyi (2007)**

examined in his paper whether an increase in the overall productivity of an economy results in an increase in production. The author founded that the standard economic perception that is an increase in overall productivity results in an increase in production holds good for short run only. But for the long run, this may not be possible.

Inklaar and Timmer (2008) argued that the standard and traditional approach for measuring output and calculating productivity has been an obsolete in the present competitive world. **Webber et al. (2009)** explained the concept and the difference between the business productivity and area productivity in rural England. Rural area productivity indicates critical significance informing rural area social welfare and policies foe social well-being. **Simpson (2009)** in his paper explored the issues arising in measurement of productivity in services provided by public sector organisations. It also explains the various approaches for measuring productivity.

Degasperi and Fredholm (2010) examined in their paper a method of productivity accounting based on production prices. The study analysed that the path of the technological progress and the growth rates in labour productivity has the significant difference between the USA and U.K. and also France and Germany. **Chalermthanakom and Ueta (2011)** explained the impact of environmental regulation on productivity in industries of Japan. **Ferreira and Martinez (2011)** focused on the employees perceptions of productivity or company investments in respect of Intellectual capital. The Bontis model of intellectual capital has been adopted by the author in the present study. The statistical tools and techniques adopted by the author is ANOVA and regression analysis. **Dogan et al. (2013)** in the paper explored the turnover, ownership and productivity in Malaysian manufacturing sector. It is also concluded that improvement in productivity should be in circular for long term survival of an industry in this fast changing and competitive conditions arising from globalization environment.

Jana and Petr (2013) presented in their study a comprehensive overview of key factors which are relevant for successful implementation of profit-sharing plan. **Rizov and Zhang (2014)** studied the regional disparities and aggregate

productivity categorized into three regional typologies based on population density, coastal-island and rural urban criteria in Chinese manufacturing firms. **Yildirim (2015)** examines in his paper the inter-relationship of the manufacturing industry of turkey for the period 1988 to 2012. The author applied Cointegration analysis and a Granger Causality Test and concluded that the inflation has a greater impact on the labour productivity as compared to the real wages. **Shepotylo and Vakhitov (2015)** analysed the productivity in manufacturing firms of Ukraine and concluded that there is a positive effect of liberalisation of services on the productivity. **Fattah (2015)** investigated the impact of research and development spillovers on Egypt's domestic total factor productivity at the industry level and concluded that the technology spillovers through FDI, whether inward or outward have positive significant impact on total factor productivity. **Mijic et al. (2015)** analyzed productivity and profitability of private and public sector companies of selected countries of Central and Eastern Europe (CEE). The outcome of the study indicated a statistically noteworthy difference in the level of productivity & profitability. **Fresenbichler and Peneder (2016)** investigated the relationship of productivity to innovation and competition in Eastern Europe as well as in Central Asia through a survey. It concluded that productivity in terms of either sales or value added per employee is positively affected by competition and innovation. **Hazarika and Boukareva (2016)** studied the financial performance measures of two major airlines companies of UAE viz. Emirates Airlines & Air Arabia is compared with reference to profitability, liquidity, efficiency, employee strength and productivity. **Berg et al. (2018)** investigated relationship between the trade status, productivity and profitability of Dutch firms and Finnish firms. The predictions of two models, the Melitz Model and the Egger Kreickemerier Model have been analysed to establish the relationship between the profit margins and the trade. **Martin and Minondo (2018)** in their paper uses highly disaggregated data to analyse the convergence process in product level relative productivity across Spanish territory. Its empirical findings point out that measures should be taken to assist the movements of people within a country, foster knowledge flows and contribute to reduce differences in product - level relative productivity across territory.

Karmarkar et al. (2015) in their paper, attempted to construct a model of an economy with endogenous production and utilization decision by utility maximizing individuals. The aim of the study is to explore in detail, the effect of productivity changes in different sectors of society. **Eldridge and Price (2016)** analysed in their study newly available GDP by industry statistics to decide whether they can be used to fabricate reasonable quarterly labor productivity measure at the industry level. **Arendt and Grabowski (2017)** developed a two way model to establish the relationship between innovation, ICT (Information and Communication Technology) use and productivity. **Gu and Yan (2017)** in their paper furnished a measure of effective multifactor productivity (MFP) growth for Canada, U.S., Australia and selected European countries. The survey has shown the MFP growth for small, open economics. The paper has also focused on changes in affiances MFP growth and its relationship with changes in relative price competitiveness.

Abad and Ravelojaona (2017) analysed in their study the Malmquist Total Factor Productivity Index and Malmquist- Luenberger Productivity Index respectively. **Shahbazi et al. (2017)** examined material efficiency of companies located in Sweden through semi structured interviews and **Flachenecker (2018)** analysed the impact of material productivity on macroeconomic competitiveness in European Unions. **Heil (2018)** in his research paper surveyed a wide range of literature and suggested that financial development has a favourable impact on productivity growth. It has also been suggested that inefficient insolvency regimes become a hurdle in the productivity growth.

Adetunji et al. (2018) examined in their study whether Corporate Social Responsibility has an influence on the organizational productivity and in return enhance the quality of service provided by Rite Food Nigeria Ltd. The author concluded that the Corporate Social Responsibility is responsible for the improvement of the organizational performance of productivity. **Rantala et al. (2018)** had explored in their study the changes took place in the obstacles restraining productivity improvement of Finnish small and medium sized enterprises covering the data from 1997 to 2014. **Pisec and Pop (2018)** has presented in his paper a tool for increasing productivity of manufacturing

companies. This tool is a program developed to track all the elements involved in production process and to plan accordingly on all the phases.

Agasisti et al. (2019) measured in their research paper the efficiency (productivity) of European education systems by combining Data Envelopment Analysis and Multiple - Criteria Evaluation. The study has concluded that the results given by the DEA method are more or less confirmed by the MCE method results. **Aminu (2019)** explained in the article the impact of MBO (Management by Objective) on employee productivity. **Aigbe et al. (2019)** aimed and analysed in their study whether technical and skilled manpower serves as a prerequisite for enhanced productivity in the Nigerian construction industry.

Globerson and Vitner (2019) have presented a model based on the two methodologies, aimed at measuring the output used in productivity of a product or a service that are producing different products. **Baily et al. (2020)** suggested that the benchmarking industry growth rates and setting productivity levels across countries are the only way to determine the weaknesses of the country in lagging behind and to find out areas where productivity gains can be achieved. **Adiguzel and Floros (2020)** found that time-driven activity based costing is highly applicable in the small-sized manufacturing companies due to its labour-intensive nature.

- **Reviews of National Level Literature**

Maheshwari (1998) in her thesis sheds light on the productivity accounting model explaining the material productivity, manpower productivity, overhead productivity and overall productivity in companies of engineering industries.

Narang et al. (2010) in their paper discloses the relationship of various components of productivity viz., business per employee, interest per employee, interest income per employee and profit per employee. This study is based on the co-operatives banks of Punjab. **Manonmani (2012)** studied the wage productivity linkages in rural, urban and cluster industries of India covering the periods from 1998-1999 to 2007-2008. The regression model has been used to understand the links between wages and productivity. **Reddy and Naidu (2013)** in their research paper studied the productivity trends of 12 Indian cement companies for a period

from the year 2000 to 2009. Partial factor (capital and labour) productivity and capital intensity has been calculated and analysed.

Deb and Ray (2014) has analysed in their paper total factor productivity growth in Indian manufacturing sector the paper compares the pre and post reform performances of Indian manufacturing related to total factor productivity growth. Data envelopment analysis has been used to construct a Biennial Malmquist index for individual states. **Gorantiwar and Shrivastava (2015)** in their paper tried to validate the quality productivity improvement framework with the help of model implementation called case study for sponge iron industry and concluded that the framework developed is valid and reliable and can also be implemented in other countries in this world with modification according to the environment of that country. **Hooda (2015)** in his paper analysed the employees' productivity performance of 31 state cooperative banks which are classified into six regions. The author found that the productivity of state cooperative banks of eastern region as compared to the others reported the good performance while in case of branch productivity, western regions bank has achieved the highest position.

Maheshwari (2016) in her paper explained the different categories of productivity models and their approaches as given by Sardana and Vrat. Seven models for measuring productivity had been discussed. Among them the most important model discussed is the Productivity Accounting Model (PAM). This model considers all the elements of output and input, ignoring the effect of inflation. **Hema (2017)** analysed the productivity and profitability of Indian banks covering a period of 5 years from 2012-13 to 2016-17. Employee productivity as well as branch productivity have been calculated and suggested that the rightsizing of branch is the only solution to improve productivity in Indian banking industry. **Maheshwari and Taparia (2019)** investigated in their paper the material productivity of pharmaceutical sector companies included in Nifty 50. The study analysed the material productivity of eight years from 2008-09 to 2015-16 of Cipla Ltd., Dr. Reddy's Laboratories Ltd., Lupin Ltd. and Sun Pharmaceutical Industries Ltd. **Padmavati and Narayanmoorthy (2019)** studied in their paper the state level data and analysed the relationship of productivity and profitability in respect of sugarcane cultivation. **Venkatesh and Saravana (2019)** stated that

the productivity has been observed to be in declining phase across the globe, majorly in construction work.

- **Research Gap**

It has been concluded from the above reviews that there is no study conducted on measurement of productivity in Nifty 50 companies and also by adopting the model, "Productivity Accounting Model" advocated by H. S. Davis during the period undertaken for the study. Thus, the present study is based on the Productivity Accounting Model considering the productivity of all the factors of production of Nifty 50 companies from 2010-11 to 2017-18 i.e. for eight years period.

8.3. Chapter 3: Research Methodology

This chapter explains the different steps taken to carry out this research, test the hypotheses and interpret the result.

- **Main Objectives of the Research**

The main objectives of the research are as follows:-

1) To understand about the various approaches of productivity measurement especially in the context of Indian economy.
2) To examine the cornerstones of productivity measurement and the techniques influencing for improvement in productivity.
3) To measure, analyse and compare the material productivity for the sampled companies included in Nifty 50.
4) To measure, analyse and compare the labour productivity for the sampled companies included in Nifty 50.
5) To measure, analyse and compare the overhead productivity for the sampled companies included in Nifty 50.
6) To measure, analyse and compare the overall productivity for the sampled companies included in Nifty 50.
7) To identify the areas wherein further improvements in terms of material productivity, labour productivity and overhead productivity are necessary.
8) To suggest various measures to improve material, labour and overhead productivity.

- **Selection of Sample**

A sample of 24 companies has been selected from the Nifty 50. These companies have been selected from Automobile, Energy, Information Technology, Metals, Pharmaceutical and Refineries sector which has a great impact on the economy of our country. Four companies have been selected from each sector according to the higher market capitalization of company. Financial institution, banking, telecommunication companies, etc. have been ignored while selecting the companies as material aspect of overall input is not there in the financial statements of these companies. Some companies have been ignored on the ground that only single company of that sector is included in Nifty 50. Selected companies and their websites are as follows:

Table 8.1

Details of Companies and their Websites

S.No.	Sector	Company	Website
1	Automobile Sector	Bajaj Auto Ltd.	www.bajajauto.com
2		Mahindra & Mahindra Ltd.	www.mahindra.com
3		Maruti Suzuki India Ltd.	www.marutisuzuki.com
4		Tata Motors Ltd.	www.tatamotors.com
5	Energy Sector	Gail (India) Ltd.	www.gailonline.com
6		NTPC Ltd.	www.ntpc.co.in
7		Oil and Natural Gas Corporation Ltd.	www.ongcindia.com
8		Power Grid Corporation of India Ltd.	www.powergridindia.com
9	Information Technology Sector	Infosys Ltd.	www.infosys.com
10		Tata Consultancy Services Ltd.	www.tcs.com
11		Tech Mahindra Ltd.	www.techmahindra.com
12		Wipro Ltd.	www.wipro.com
13	Metals Sector	Coal India Ltd.	www.coalindia.in
14		Hindalco Ltd.	www.hindalco.com
15		Tata Steel Ltd.	www.tatasteel.com
16		Vedanta Ltd.	www.vedantalimited.com
17	Pharmaceutical Sector	Cipla Ltd.	www.cipla.com
18		Dr. Reddy's laboratories Ltd.	www.drreddys.com
19		Lupin Ltd.	www.lupin.com
20		Sun Pharmaceutical Industries Ltd.	www.sunpharma.com
21	Refineries	Bharat Petroleum Corporation Ltd.	www.bharatpetroleum.com

22	Sector	Hindustan Petroleum Corporation Ltd.	www.hindustanpetroleum.com
23		Indian Oil Corporation Ltd.	www.iocl.com
24		Reliance Industries Ltd.	www.ril.com

Source: https://www.nseindia.com/products/content/equities/indices/nifty_50.htm on 25.07.2018.

- **Type of Research**

The present study is explorative, conceptual and empirical in nature. The **explorative** studies tend to explore the research topic with varying levels of depth with the objective of discovering future research tasks. The **empirical** study is the one based on the observation and experiences from the data available quantitatively and qualitatively. From **conceptual** viewpoint, the study has examined the meaning, history, purpose, importance of productivity accounting and its measurement.

- **Research Design**

1. **Collection of Data:** The research is based on the secondary data. The data and information have been obtained from the annual reports of the respective companies. In order to remove the inflation effect of prices on output and inputs, the revaluation of the values of output and inputs has been made in accordance with the index numbers as per RBI bulletins.

2. **Period of Study:** The present study covers a period of eight financial years from 2010-11 to 2017-18.

3. **Selection of Base Year:** The year 2010-11 has been taken as the base year. The revaluation of output and inputs is done on the basis of base year prices.

4. **Model to be used:** In the present research, the model propogated by H. S. Davis which is Productivity Accounting Model has been used for measuring productivity. It has been used because it considers all the elements of output and input, ignoring the effect of inflation. This model suggests that the output as well as input should be measured in terms of money so that the comparison is possible as for all companies the base of measurement is monetary.

5. **Variables Used:** The variables used in the present study are output and input. For calculating output and input, monetary values have been considered. Output and input both have been revalued on the basis of price index as per bulletins of RBI.

6. **Revaluation of Output:** Output consists of Revenue from operations, other income and changes in the inventories of finished goods, work in progress and traded goods and are revalued as per the wholesale price index published in RBI bulletin.

7. **Revaluation of Input:** Material input consists of raw material and components, stores and spares and purchases of traded goods. Labour input consists of salary, wages, bonus and benefits, contribution to provident and other funds and employees welfare expenses and others. All the remaining are covered under the overhead input. Overheads have been divided into major four heads power and fuel, depreciation and amortization, repairs and maintenance and lastly business service input. Business service input includes all the other overhead expenses which are not covered under the above three heads. One more thing is added in the input that is the investor input. It is an additional cost for which the company pays the cost in the form of interest, royalty, profit, etc.

8. **Calculation of Index Numbers and Conversion Factors:** Index numbers and conversion factors have been used for revaluation of data on the base year's prices for eight years from 2010-11 to 2017-18. Consumer price index for industrial workers has been used for revaluating labour input. Fuel and power index has been used for revaluating fuel and power expenses in the overhead input. And in rest of the cases wholesale price index has been used for revaluation. Here the year 2010-11 has been taken as base year.

Following formula has been used to calculate conversion factors:

$$\frac{\text{Index number of the base year}}{\text{Index number for the current year}}$$

Revaluated output as well as revaluated input can be obtained by multiplying conversion factors with the actual values of output as well as of input.

Backward splicing technique has been used for calculating the index numbers of 2010-11.

Table 8.2

Index Numbers and the Conversion Factors for Revaluation of Data

Year	Wholesale Price Index Base year 2011-12 = 100	Conversion Factors	Consumer Price Index for Industrial Workers Base Year 2001 = 100	Conversion Factors	Fuel and Power Index Base Year 2011-12 = 100	Conversion Factors
2010-11	91.80	1.000	180.00	1.000	87.75	1.000
2011-12	100.00	0.918	195.00	0.923	100.00	0.878
2012-13	106.90	0.859	215.00	0.837	107.10	0.819
2013-14	112.50	0.816	236.00	0.763	114.70	0.765
2014-15	113.90	0.806	251.00	0.717	107.70	0.815
2015-16	109.70	0.837	265.00	0.679	86.50	1.014
2016-17	111.60	0.823	276.00	0.652	86.30	1.017
2017-18	114.90	0.799	284.00	0.634	93.30	0.941

- **Research Hypotheses and Testing**

Keeping in mind the objectives of the research work the null and alternative hypotheses have been developed and tested. Here only null hypotheses are being given.

Intra-company Comparison

Four hypotheses have been developed and tested for intra-company comparison. Intra-company hypotheses has been tested and analysed with the help of the non-parametric chi-square test.

1) **Material Productivity**

Null Hypothesis (H_0): There is no significant difference in the material productivity indices of the sampled company for the study period and can be represented by straight line trend or line of best fit.

2**) Labour Productivity**

Null Hypothesis (H_0): There is no significant difference in the labour productivity indices of the sampled company for the study period and can be represented by straight line trend or line of best fit.

3) **Overhead Productivity**

Null Hypothesis (H_0): There is no significant difference in the overhead productivity indices of the sampled company for the study period and can be represented by straight line trend or line of best fit.

4) **Overall Productivity**

Null Hypothesis (H_0): There is no significant difference in the overall productivity indices of the sampled company for the study period and can be represented by straight line trend or line of best fit.

The acceptance of null hypothesis would reveal that the productivity indices of the sampled company for the study period are approximately equal and can be represented by straight line trend or line of best fit. However, rejection of null hypothesis and acceptance of alternate hypothesis would mean that the productivity indices of the sampled company differ in the study period indicates that indices cannot be represented by straight line trend.

Inter-company Comparison

A comparison and analysis has been drawn between the sampled 24 companies. To compare the different companies of different sectors four hypotheses have been developed which have been tested by kruskal wallis one way analysis of variance test popularly known as H test.

1) **Material Productivity**

Null Hypothesis (H_0): There is no significant difference in the material productivity ratios of sampled companies.

2) **Labour Productivity**

Null Hypothesis (H_0): There is no significant difference in the labour productivity ratios of sampled companies.

3) **Overhead Productivity**

Null Hypothesis (H_0): There is no significant difference in the overhead productivity ratios of sampled companies.

4) **Overall Productivity**

Null Hypothesis (H_0): There is no significant difference in the overall productivity ratios of sampled companies.

The acceptance of null hypothesis would reveal that the productivity ratios of sampled companies are approximately equal. However, rejection of null hypothesis would mean that the productivity ratios between the sampled companies differ.

The various other statistical tools and techniques used in the study are Mean (Average), Ranks, Standard deviation, Coefficient of variation, etc.

- **Referencing**

Referencing has been made as per 6th edition of standard format recommended by American Psychological Association (APA).

8.4. Chapter 4: Material Productivity

Materials are regarded as the most essential element of production in an organisation. Thus, its productivity is very essential to measure. Material productivity indicates that how much has been produced as output by a unit of material input.

Material Productivity Ratio: $\frac{\text{Total Output}}{\text{Material Input}}$

Higher ratio indicates efficiency and effectiveness while lower ratio indicates that the material input has not been utilized efficiently.

Material Control and its productivity can be improved by improving the quality of raw material used in the production process, technology used in raw material processing, material handling transportation system, equipment used in the production process should be of good quality and efficient design so less number of defective products are produced. Proper and effective storage space should be there to avoid goods from storage damages. Proper, collective segregation, efficient recycling of scrap should be done to avoid wastage.

- **Steps in Measurement of Material Productivity**

1. **Revaluation of Material Input at Base Year Prices**

- Material input in this study includes raw material and components including packing material consumed, stores and spares consumed and purchases of traded goods.
- The wholesale price index has been used for revaluing the raw material input

2. **Computation and Analysis of Material Productivity Ratios and Material Productivity Indices.**

- Material productivity ratio means output at base year prices per rupee of material input.

- Material productivity indices have been calculated assuming base year material productivity ratio as 100.

3. Testing Hypotheses

- Intra-company hypothesis has been developed to compare the material productivity of the sample companies for the study period and tested through chi-square test.
- Inter-company hypothesis has been developed to study the inter-company relationship with regards to material productivity and tested through kruskal wallis one way analysis of variance test.

4. Computation of Possible Savings

- Possible Saving in Material Input = Actual material input – Standard material input.
- Standard Material Input = Minimum requirement of material input per ₹ of output X Actual output revalued according to the base year.

➢ **Analysis of Average Material Productivity Ratios**

To make comparison of material productivity between the companies of a particular sector it is better to analyse its average performance for the study period.

Automobile Sector: The total material average input output ratio is the best of Bajaj Auto Ltd. with 0.6893, followed by Maruti Suzuki India Ltd. with 0.7155, Tata Motors Ltd. with 0.7181 and Mahindra & Mahindra Ltd. 0.7200. Average material productivity ratio is the best of Bajaj Auto Ltd. with 1.4529 which means that for every one ₹ of material input, the output produced is 1.4529. This is followed by Maruti Suzuki India Ltd. with 1.4020 then Tata Motors Ltd. with 1.3954 and lastly Mahindra & Mahindra Ltd. with 1.3907.

Energy Sector: The total material average input output ratio is the best of Oil and Natural Gas Corporation Ltd. with 0.0530, followed by NTPC Ltd. with 0.6144 and GAIL (India) Ltd. with 0.7674. Average material productivity ratio is the best of Oil and Natural Gas Corporation Ltd. with 20.2175 which means that for every one ₹ of material input, the output produced is approximately ₹ 20. This is followed by NTPC Ltd. with 1.6296 and lastly GAIL (India) Ltd. with 1.3044.

Information Technology Sector: The total material average input output ratio is the best of Tata Consultancy Services Ltd., followed by Infosys Ltd. and Wipro Ltd. Average material productivity ratio is the highest of Tata Consultancy Services Ltd. with 1560.5800, followed by Infosys Ltd. with 51.4073 and Wipro Ltd. with 16.3281.

Metals Sector: The total material average input output ratio is the best of Coal India Ltd. with 0.0010, followed by Tata Steel Ltd. with 0.3097, Vedanta Ltd. with 0.4001 and Hindalco Ltd. with 0.6362. Average material productivity ratio is the higher of Coal India Ltd. with 1209.8458, followed by Vedanta Ltd. with 3.3815, Tata Steel Ltd. with 3.2526 and Hindalco Ltd. with 1.5802.

Pharmaceutical Sector: The total material average input output ratio is the best of Dr. Reddy's Laboratories Ltd., followed by Lupin Ltd., Sun Pharmaceutical Industries Ltd. and Cipla Ltd. Average material productivity ratio is the best of Dr. Reddy's Laboratories Ltd. with 3.2333, followed by Lupin Ltd. with 2.6766, Sun Pharmaceutical Industries Ltd. with 2.6187 and lastly Cipla Ltd. with 2.4152.

Refineries Sector: The total material average input output ratio is the best of Reliance Industries Ltd. with 0.7741, followed by Indian Oil Corporation Ltd. with 0.8700, Bharat Petroleum Corporation Ltd. with 0.9006 and Hindustan Petroleum Corporation Ltd. with 0.9088. Average material productivity ratio is the best of Reliance Industries Ltd. with 1.3017 which means that for every one ₹ of material input, the output produced is approximately ₹ 1.3017. This is followed by Indian Oil Corporation Ltd. with 1.1526, Bharat Petroleum Corporation Ltd. with 1.1120 and Hindustan Petroleum Corporation Ltd. with 1.1017.

- **Possible Savings in Material Input**

Possible savings has been calculated to analyse what would have been saved if optimum utilisation of resources is made.

Automobile Sector: Total possible savings in material input of automobile sector companies for a period of eight years would have been ₹ 5311 crore of Bajaj Auto Ltd., ₹ 9465 crore of Mahindra & Mahindra Ltd., ₹ 13262 crore of Maruti Suzuki India Ltd. and lastly ₹ 14369 crore of Tata Motors Ltd. For calculating possible savings year of the lowest material input output ratio has been taken as the base year. The year 2015-16 has been regarded as the base year for Bajaj Auto Ltd.,

Maruti Suzuki India Ltd. and Tata Motors Ltd. For Mahindra and Mahindra Ltd. base year is 2017-18.

Energy Sector: The total possible savings in material input of energy sector companies for a period of eight years would have been ₹ 12976 crore of GAIL (India) Ltd., ₹ 14942 crore of NTPC Ltd. and ₹ 13119 crore of Oil and Natural Gas Corporation Ltd. Possible savings have been calculated by multiplying the minimum input output ratio with the output of the respective year.

Information Technology Sector: The total possible savings in material input of information technology would have been ₹ 437 crore of Infosys Ltd. It would be ₹ 3078 crore of Tata Consultancy Services Ltd. It would be ₹ 11484 of Wipro Ltd. For calculating possible savings year of the lowest material input output ratio has been taken as the base year.

Metals Sector: The total possible savings in material input of Metals sector companies for a period of eight years would have been ₹ 32 crore of Coal India Ltd., ₹ 15617 crore of Hindalco Ltd., ₹ 14023 crore of Tata Steel Ltd. and lastly ₹ 61625 crore of Vedanta Ltd. For calculating possible savings, year of the lowest material input output ratio has been taken as the base year. The year 2016-17 has been regarded as the base year for Coal India Ltd., 2015-16 for Hindalco Ltd. and 2010-11 for Tata Steel Ltd. and Vedanta Ltd.

Pharmaceutical Sector: The total possible savings in material input of pharmaceutical sector companies would have been ₹ 2437 crore of Cipla Ltd., ₹ 1487 crore of Dr. Reddy's Laboratories Ltd., ₹ 3033 of Lupin Ltd. and lastly ₹ 4970 crore of Sun Pharmaceutical Industries Ltd.

Refineries Sector: The total possible savings in material input of refineries sector companies for a period of eight years would have been ₹ 85067 crore of Bharat Petroleum Corporation Ltd., ₹ 52075 crore of Hindustan Petroleum Corporation Ltd., ₹ 208996 crore of Indian Oil Corporation Ltd. and lastly ₹ 262423 crore of Reliance Industries Ltd. For calculating possible savings, year of the lowest material input output ratio has been taken as the base year. The year 2015-16 has been regarded as the base year for Bharat Petroleum Corporation Ltd., Hindustan Petroleum Corporation Ltd. and Reliance Industries Ltd. For Indian Oil Corporation Ltd. base year is 2017-18.

- **Material Productivity and Chi-square Test**

Material productivity of different companies of Nifty 50 has been calculated for the study period, chi-square test has been applied and analysis has been drawn out of it.

Table 8.3

Chi-square Test on Material Productivity of Companies from 2010-11 to 2017-18

S. No.	Company Name	Chi-square Value	Null Hypothesis Testing
1	Bajaj Auto Ltd.	0.273	Accepted
2	Mahindra & Mahindra Ltd.	0.660	Accepted
3	Maruti Suzuki India Ltd.	0.292	Accepted
4	Tata Motors Ltd.	1.212	Accepted
5	GAIL (India) Ltd.	0.769	Accepted
6	NTPC Ltd.	0.684	Accepted
7	Oil and Natural Gas Corporation Ltd.	17.257	Rejected
8	Power Grid Corporation of India Ltd.	67.543	Rejected
9	Infosys Ltd.	0.622	Accepted
10	Tata Consultancy Services Ltd.	190.885	Rejected
11	Tech Mahindra Ltd.	-	-
12	Wipro Ltd.	40.609	Rejected
13	Coal India Ltd.	67.489	Rejected
14	Hindalco Ltd.	1.636	Accepted
15	Tata Steel Ltd.	2.593	Accepted
16	Vedanta Ltd.	53.572	Rejected
17	Cipla Ltd.	2.365	Accepted
18	Dr. Reddy's laboratories Ltd.	2.752	Accepted
19	Lupin Ltd.	4.469	Accepted
20	Sun Pharmaceutical Industries Ltd.	7.936	Accepted
21	Bharat Petroleum Corporation Ltd.	0.650	Accepted
22	Hindustan Petroleum Corporation Ltd.	0.353	Accepted
23	Indian Oil Corporation Ltd.	0.575	Accepted
24	Reliance Industries Ltd.	2.918	Accepted

If the computed value of chi-square is less as compared to the table value of chi-square 14.067 at 5% level of significance with (8-1) = 7 degree of freedom, null hypothesis is accepted. This reveals that the material productivity indices of the company for the study period are approximately equal and can be represented by straight line trend or line of best fit.

If the calculated value of chi-square is more as compared to the table value 14.067, null hypothesis is rejected. This reveals that the material productivity

indices of the company for the study period are not approximately same and cannot be represented by straight line trend or line of best fit.

- **Material Productivity Ratios and Kruskal Wallis One Way Analysis of Variance Test**

The material productivity of all the samples of a particular sector is combined and arranged in order of increasing size and given a rank number. Where the tie occur the mean of the available rank numbers is used. The rank sum of each of the sample has been calculated and test is applied.

Table 8.4

Material Productivity Ratios and Kruskal Wallis One Way Analysis of Variance Test

S. No.	Sector Name	Table Value	H Value	Null Hypothesis Testing
1	Automobile Sector	7.815	4.026	Accepted
2	Energy Sector	5.991	20.480	Rejected
3	Information Technology Sector	5.991	19.280	Rejected
4	Metals Sector	7.815	25.185	Rejected
5	Pharmaceutical Sector	7.815	13.017	Rejected
6	Refineries Sector	7.815	17.739	Rejected

If the calculated value of H is less than the table value at 5% level of significance, null hypothesis is accepted. This means that the material productivity ratios of the sector companies of Nifty 50 are approximately same that is there is no significant difference in material productivity.

If the calculated value is more than the table value null hypothesis is rejected. This means that the material productivity ratios of the sector companies of Nifty 50 are not same that is there is a significant difference in material productivity.

- **Suggestions for Improvement**

The companies can take steps to reduce cost by optimally utilizing the material cost by improving the quality of raw material, improving technology of raw material processing and material handling transportation system. Companies can also take steps in implementation of new methods of accounting in the organisation such as ERP, SAP, etc. so that less time is involved in day to day activities hence creating productivity. Companies can also adopt the method of outsourcing the work.

8.5. Chapter 5: Labour Productivity

Labour also plays a vital role in the production process in an organisation. All the other factors of productivity will remain idle if its labour input is not utilised efficiently. Labour is responsible for the optimum utilisation of other factor of production. Therefore, its productivity is equally important.

Perfect coordination and cooperation is required in the departments which deal with labour cost to obtain the maximum productivity out of it. These departments include personnel department, time recording department, pay roll department, engineering department, cost accounting department.

Labour cost can be improved by adopting the techniques such as:

- Appreciate the employees for good things in public and try to blame them for wrong sins in private. This will encourage them with the positive attitude towards the organisation.
- Try to create and maintain a friendly environment which can help the employees to come together and share their knowledge.
- Top management should try to avoid conflicts among the employees and also between the management and workers.

➢ **Steps in Measurement of Labour Productivity**

1. **Revaluation of Labour Input at Base Year Prices**

- Labour input in this study includes salary, wages, bonus and benefits, contribution to provident and other funds and employees welfare expenses and others.
- The consumer price index for industrial workers has been used for revaluing the labour input.

2. **Computation and Analysis of Labour Productivity Ratios and Labour Productivity Indices.**

- Labour productivity ratio means output at base year prices per rupee of labour input.
- Labour productivity indices have been calculated assuming base year labour productivity ratio as 100.

3. Testing Hypotheses

- Intra-company hypothesis developed to compare labour productivity of the sampled companies for the study period and tested through chi-square test.
- Inter-company hypothesis developed to study the inter-company relationship and tested through kruskal wallis one way analysis of variance test.

4. Computation of Possible Savings

- Possible Saving in Labour Input = Actual labour input – Standard labour input
- Standard Labour Input = Minimum requirement of labour input per ₹ of output X Actual output revalued according to the base year.

➢ **Analysis of Average Labour Productivity Ratios**

Automobile Sector: The total labour average input output ratio is the best of Maruti Suzuki India Ltd. with 0.0256, followed by Bajaj Auto Ltd. with 0.0316, Mahindra & Mahindra Ltd. 0.0498 and lastly Tata Motors Ltd. with 0.0593. Average labour productivity ratio is the best of Maruti Suzuki India Ltd. with 39.8114 which means that for one ₹ of labour input, the output produced is approximately ₹ 40. This is followed by Bajaj Auto Ltd. with 31.8770, Mahindra & Mahindra Ltd. with 20.2732 and lastly Tata Motors Ltd. with 17.2582.

Energy Sector: The total labour average input output ratio is the best of GAIL (India) Ltd. with 0.0169, followed by NTPC Ltd. with 0.0454, Power Grid Corporation of India Ltd. with 0.0566 and lastly Oil and Natural Gas Corporation Ltd. with 0.0968. Average labour productivity ratio is the best of GAIL (India) Ltd. with 60.9335 which means that for one ₹ of labour input, the output produced is approximately ₹ 61. This is followed by NTPC Ltd. with 22.1025, Power Grid Corporation of India Ltd. with 19.1242 and lastly Oil and Natural Gas Corporation Ltd. with 10.4527.

Information Technology Sector: The total labour average input output ratio is the best in Tata Consultancy Services Ltd. as compared to other companies of information technology sector. Average labour productivity ratio is the best in Tech Mahindra Ltd. with 3.0551. This is followed by Tata Consultancy Services Ltd. then Wipro Ltd. and lastly Infosys Ltd.

Metals Sector: The total labour average input output ratio is the best of Vedanta Ltd. with 0.0240, followed by Coal India Ltd. with 0.0290, Hindalco Ltd. with

0.0405 and lastly Tata Steel Ltd. with 0.0836. Average labour productivity ratio is the best of Vedanta Ltd. with 56.4281. This is followed by Coal India Ltd. with 38.3420 then Hindalco Ltd. with 24.8515 and lastly Tata Steel Ltd. with 12.2288.

Pharmaceutical Sector: The total labour average input output ratio is the best of Lupin Ltd. with 0.0982, followed by Sun Pharmaceutical Industries Ltd. with 0.1129, Cipla Ltd. with 0.1143 and lastly Dr. Reddy's Laboratories Ltd. with 0.1326. Average labour productivity ratio is the best of Lupin Ltd. with 10.3079. This is followed by Sun Pharmaceutical Industries Ltd. with 9.8738 then Cipla Ltd. with 9.0271 and lastly Dr. Reddy's Laboratories Ltd. with 7.5841.

Refineries Sector: The total labour average input output ratio is the best of Reliance Industries Ltd. with 0.0109, followed by Hindustan Petroleum Corporation Ltd. with 0.0110, Bharat Petroleum Corporation Ltd. with 0.0120 and lastly Indian Oil Corporation Ltd. with 0.0165. Average labour productivity ratio is the best of Reliance Industries Ltd. with 96.5455. This is followed by Hindustan Petroleum Corporation Ltd. with 94.1102 then Bharat Petroleum Corporation Ltd. with 88.5134 and lastly Indian Oil Corporation Ltd. with 63.1303.

- **Possible Savings in Labour Input**

Possible savings in labour input has been calculated to analyse what would have been saved if the labour input is optimally utilized.

Automobile Sector: Possible savings in labour input of Bajaj Auto Ltd. would have been ₹ 669 crore, ₹ 1232 crore of Mahindra & Mahindra Ltd., ₹ 2455 crore of Maruti Suzuki India Ltd. and lastly ₹ 2947 crore of Tata Motors Ltd. For calculating possible savings year of the lowest labour input output ratio has been taken as the base year. The year 2011-12 has been regarded as the base year for Bajaj Auto Ltd. For Mahindra and Mahindra Ltd. base year is 2012-13. For Maruti Suzuki India Ltd. and Tata Motors Ltd. base year is 2010-11.

Energy Sector: The total possible savings in labour input for a period of eight years would have been ₹ 982 crore of GAIL (India) Ltd., ₹ 2237 crore of NTPC Ltd., ₹ 7664 crore of Oil and Natural Gas Corporation Ltd. and ₹ 1743 crore of Power Grid Corporation of India Ltd. Possible savings have been calculated by multiplying the minimum input output ratio with the output of the respective year.

Information Technology Sector: The total possible savings in labour input would have been ₹ 14259 crore of Infosys Ltd., ₹ 30793 crore of Tata Consultancy Services Ltd., ₹ 5862 crore of Tech Mahindra Ltd. and lastly ₹ 10669 crore of Wipro Ltd. For calculating possible savings year of the lowest labour input output ratio has been taken as the base year.

Metals Sector: The total possible savings in labour input for a period of eight years would have been ₹ 716 crore of Coal India Ltd., ₹ 1166 crore of Hindalco Ltd., ₹ 5746 crore of Tata Steel Ltd. and lastly ₹ 552 crore of Vedanta Ltd.

Pharmaceutical Sector: The total possible savings in labour input would have been ₹ 2732 crore of Cipla Ltd. ₹ 1113 crore of Dr. Reddy's Laboratories Ltd., ₹ 651 crore of Lupin Ltd. and lastly ₹ 2422 crore of Sun Pharmaceutical Industries Ltd.

Refineries Sector: The total possible savings in labour input for a period of eight years would have been ₹ 6047 crore of Bharat Petroleum Corporation Ltd. with 2014-15 as a base year, ₹ 3024 crore of Hindustan Petroleum Corporation Ltd. with 2013-14 as a base year, ₹ 13110 crore of Indian Oil Corporation Ltd. with 2011-12 as a base year and lastly ₹ 5394 crore of Reliance Industries Ltd. with 2013-14 as a base year.

- **Labour Productivity and Chi-square Test**

Labour productivity of companies of six sectors of Nifty 50 has been calculated and analysis has been drawn out of it.

Table 8.5

Chi-square Test on Labour Productivity of Companies from 2010-11 to 2017-18

S. No.	Company Name	Chi-square Value	Null Hypothesis Testing
1	Bajaj Auto Ltd.	3.016	Accepted
2	Mahindra & Mahindra Ltd.	4.749	Accepted
3	Maruti Suzuki India Ltd.	5.068	Accepted
4	Tata Motors Ltd.	13.193	Accepted
5	GAIL (India) Ltd.	26.646	Rejected
6	NTPC Ltd.	1.443	Accepted
7	Oil and Natural Gas Corporation Ltd.	9.346	Accepted
8	Power Grid Corporation of India Ltd.	10.289	Accepted
9	Infosys Ltd.	1.972	Accepted
10	Tata Consultancy Services Ltd.	11.706	Accepted

11	Tech Mahindra Ltd.	8.528	Accepted
12	Wipro Ltd.	2.177	Accepted
13	Coal India Ltd.	107.206	Rejected
14	Hindalco Ltd.	1.324	Accepted
15	Tata Steel Ltd.	8.106	Accepted
16	Vedanta Ltd.	72.090	Rejected
17	Cipla Ltd.	10.719	Accepted
18	Dr. Reddy's laboratories Ltd.	3.294	Accepted
19	Lupin Ltd.	9.013	Accepted
20	Sun Pharmaceutical Industries Ltd.	12.135	Accepted
21	Bharat Petroleum Corporation Ltd.	69.482	Rejected
22	Hindustan Petroleum Corporation Ltd.	32.335	Rejected
23	Indian Oil Corporation Ltd.	33.676	Rejected
24	Reliance Industries Ltd.	19.682	Rejected

If the calculated value of chi-square is less as compared to the table value 14.067 at 5% level of significance with (8-1) = 7 degree of freedom, null hypothesis is accepted. This reveals that the labour productivity indices of the company for the study period are approximately equal and can be represented by straight line trend or line of best fit.

If the calculated value of chi-square is more as compared to the table value, null hypothesis is rejected. This reveals that the labour productivity indices of the company for the study period are not equal and cannot be represented by straight line trend or line of best fit.

- **Labour Productivity Ratios and Kruskal Wallis One Way Analysis of Variance Test**

The labour productivity of all the samples is combined and arranged in order of increasing size and given a rank number.

Table 8.6

Labour Productivity Ratios and Kruskal Wallis One Way Analysis of Variance Test

S. No.	Sector Name	H Value	Null Hypothesis Testing
1	Automobile Sector	26.636	Rejected
2	Energy Sector	26.466	Rejected
3	Information Technology Sector	13.935	Rejected
4	Metals Sector	21.872	Rejected
5	Pharmaceutical Sector	9.281	Rejected
6	Refineries Sector	11.514	Rejected

The calculated value is greater than the table value 7.815 at 5% level of significance with (4-1) = 3 degrees of freedom for all the companies hence null hypothesis is rejected. This means that the labour productivity ratios of the companies included in Nifty 50 are not same that is there is significance difference in the labour productivity ratios.

- **Suggestions for Improvement**

The labour can be optimally utilised by adopting techniques such as incentive schemes, workers participation in the management, job enrichment, flexitime etc. Labour can also be encouraged by organizing social events and awarding and rewarding them in it. This will boost the morale of the employees and a feeling of positive competition is developed among them. It is also recommended that aged, old and retiring skilled persons should provide a kind of mentorship for new entrants or those who are already in the job.

8.6. Chapter 6: Overhead Productivity

The sum of all other expenses excluding the direct material, direct labour constitutes the overhead. In the present study, overheads has been classified as power and fuel, depreciation and amortisation, repairs and maintenance and the residual overhead expenses constitutes the business service input. It is compared with the output to obtain the overhead productivity.

- **Steps in Measurement of Overhead Productivity**

1. Revaluation of Overhead Input at Base Year Prices

- Overhead input in this study includes power and fuel, depreciation and amortisation, repairs and maintenance and lastly business service input. Business service input includes the other overhead expenses which are not able to classify in the specified overhead head.
- All the overhead inputs have been revalued with the different index numbers according to the nature of overheads. Power and fuel has been revalued with the fuel and power index. Repairs and maintenance and business service input have been revalued with the wholesale price index. Depreciation and amortisation has not been revalued at all.

2. Computation and Analysis of Overhead Productivity Ratios and Overhead Productivity Indices.

- Overhead productivity ratio means output at base year prices per rupee of overhead input.
- Overhead productivity indices have been calculated assuming base year 2010-11 overhead productivity ratio as 100.

3. Testing Hypotheses

- Intra-company hypothesis, to compare the overhead productivity of the sampled companies for the study period has been tested through chi-square test.
- Inter-company hypothesis, to study the inter-company relationship in regard to overhead productivity has been tested through kruskal wallis one way analysis of variance test.

4. Computation of Possible Savings.

- Possible Saving in Overhead Input = Actual overhead input – Standard overhead input
- Standard Overhead Input = minimum requirement of overhead input per ₹ of output X Actual output revalued according to the base year.

➢ **Analysis of Average Overhead Productivity Ratios**

Automobile Sector: The total overhead average input output ratio is the best of Bajaj Auto Ltd. with 0.0637, Mahindra & Mahindra Ltd. with 0.1234, Maruti Suzuki India Ltd. with 0.1680 and lastly Tata Motors Ltd. with 0.2063. The average overhead productivity ratio is the best of Bajaj Auto Ltd. with 16.4343 which means that for one ₹ of overhead input, the output produced is approximately ₹ 16. This is followed by Mahindra & Mahindra Ltd. with 8.2461, then Maruti Suzuki India Ltd. with 6.0485 and lastly Tata Motors Ltd. with 5.0441.

Energy Sector: The total overhead average input output ratio is the best of GAIL (India) Ltd. with 0.1059 followed by NTPC Ltd., Power Grid Corporation of India Ltd. and lastly Oil and Natural Gas Corporation Ltd. with 0.5328. The average overhead productivity ratio is the best of GAIL (India) Ltd. with 9.5189 which means that for every one ₹ of overhead input, the output produced is

approximately ₹ 9.5189. This is followed by NTPC Ltd. with 7.2808, then Power Grid Corporation of India Ltd. with 2.6115 and lastly Oil and Natural Gas Corporation Ltd. with 1.8855.

Information Technology Sector: The total overhead average input output ratio is the best of Infosys Ltd. with 0.1756, Wipro Ltd. with 0.2577, Tata Consultancy Services Ltd. with 0.3050 and lastly Tech Mahindra Ltd. with 0.4581. Average overhead productivity ratio is the best of Infosys Ltd. with 5.7175. This is followed by Wipro Ltd. with 3.8989, then Tata Consultancy Services Ltd. with 3.5628 and lastly Tech Mahindra Ltd. with 2.2024.

Metals Sector: The total overhead average input output ratio is the best of Coal India Ltd. with 0.0289, Hindalco Ltd. with 0.2520, Vedanta Ltd. with 0.3334 and lastly Tata Steel Ltd. with 0.3718. Average overhead productivity ratio is the best of Coal India Ltd. with 38.3249. This is followed by Hindalco Ltd. with 4.2212, then Vedanta Ltd. with 3.3428 and lastly Tata Steel Ltd. with 2.7600.

Pharmaceutical Sector: The total overhead average input output ratio is the best of Lupin Ltd. with 0.2718 as compared to others. Average overhead productivity ratio is the best of Lupin Ltd. with 3.7084. This is followed by Cipla Ltd. with 3.2826, then Sun Pharmaceutical Industries Ltd. with 3.2248 and lastly Dr. Reddy's Laboratories Ltd. with 2.6038.

Refineries Sector: The total overhead average input output ratio is the best of Hindustan Petroleum Corporation Ltd. with 0.0602, Bharat Petroleum Corporation Ltd. with 0.0604, Indian Oil Corporation Ltd. with 0.0796 and lastly Reliance Industries Ltd. with 0.1106. Average overhead productivity ratio is the best of Hindustan Petroleum Corporation Ltd. with 17.1615. This is followed by Bharat Petroleum Corporation Ltd. with 17.1182, then Indian Oil Corporation Ltd. with 13.4887 and lastly Reliance Industries Ltd. with 9.6764.

- **Possible Savings in Overhead Input**

Possible savings has been calculated to analyse what would have been saved if optimum utilisation of overhead input is made.

Automobile Sector: The total possible savings in overhead input for a period of eight years might be ₹ 2815 crore of Bajaj Auto Ltd., ₹ 6637 crore of Mahindra &

Mahindra Ltd., ₹ 13449 crore of Maruti Suzuki India Ltd. and lastly ₹ 18114 crore of Tata Motors Ltd.

Energy Sector: The total possible savings in overhead input would have been ₹ 4260 crore of GAIL (India) Ltd., ₹ 20966 crore of NTPC Ltd., ₹ 29495 crore of Oil and Natural Gas Corporation Ltd. and lastly ₹ 10076 crore of Power Grid Corporation of India Ltd. For calculating possible savings year of the lowest overhead input output ratio has been taken as the base year.

Information Technology Sector: The total possible savings in overhead input for a period of eight years would have been ₹ 6091 crore of Infosys Ltd., ₹ 52304 crore of Tata Consultancy Services Ltd., ₹ 9148 crore of Tech Mahindra Ltd. and lastly ₹ 5731 crore of Wipro Ltd.

Metals Sector: Total possible savings in overhead input for a period of eight years would be ₹ 680 crore of Coal India Ltd., ₹ 10002 crore of Vedanta Ltd., ₹ 17118 crore of Hindalco Ltd. and lastly ₹ 26463 crore of Tata Steel Ltd.

Pharmaceutical Sector: The total possible savings in overhead input would have been ₹ 2048 crore of Cipla Ltd., ₹ 2007 crore of Dr. Reddy's Laboratories Ltd., ₹ 1847 crore of Lupin Ltd. and lastly ₹ 6589 crore of Sun Pharmaceutical Industries Ltd. For calculating possible savings year of the lowest overhead input output ratio has been taken as the base year. The year 2013-14 has been regarded as the base year for Cipla Ltd. and Lupin Ltd. while the year 2012-13 is regarded as the base year for Dr. Reddy's Laboratories Ltd. and 2011-12 is considered as a base year for Sun Pharmaceutical Industries Ltd.

Refineries Sector: The total possible savings in overhead input for a period of eight years would have been ₹ 18384 crore of Bharat Petroleum Corporation Ltd., ₹ 14221 crore of Hindustan Petroleum Corporation Ltd., ₹ 58811 crore of Indian Oil Corporation Ltd. and lastly ₹ 57790 crore of Reliance Industries Ltd. For calculating possible savings year of the lowest overhead input output ratio has been taken as the base year.

- **Overhead Productivity and Chi-square Test**

Overhead productivity of companies of six sectors included in Nifty 50 has been calculated and analysis has been drawn with the help of chi-square test.

Table 8.7

Chi-square Test on Overhead Productivity of Companies from 2010-11 to 2017-18

S. No.	Company Name	Chi-square Value	Null Hypothesis Testing
1	Bajaj Auto Ltd.	5.165	Accepted
2	Mahindra & Mahindra Ltd.	2.336	Accepted
3	Maruti Suzuki India Ltd.	7.403	Accepted
4	Tata Motors Ltd.	12.016	Accepted
5	GAIL (India) Ltd.	1.754	Accepted
6	NTPC Ltd.	6.982	Accepted
7	Oil and Natural Gas Corporation Ltd.	1.718	Accepted
8	Power Grid Corporation of India Ltd.	1.096	Accepted
9	Infosys Ltd.	2.393	Accepted
10	Tata Consultancy Services Ltd.	41.852	Rejected
11	Tech Mahindra Ltd.	3.948	Accepted
12	Wipro Ltd.	1.011	Accepted
13	Coal India Ltd.	121.065	Rejected
14	Hindalco Ltd.	5.222	Accepted
15	Tata Steel Ltd.	4.808	Accepted
16	Vedanta Ltd.	48.543	Rejected
17	Cipla Ltd.	2.586	Accepted
18	Dr. Reddy's laboratories Ltd.	2.029	Accepted
19	Lupin Ltd.	6.155	Accepted
20	Sun Pharmaceutical Industries Ltd.	39.108	Rejected
21	Bharat Petroleum Corporation Ltd.	6.302	Accepted
22	Hindustan Petroleum Corporation Ltd.	9.032	Accepted
23	Indian Oil Corporation Ltd.	8.072	Accepted
24	Reliance Industries Ltd.	23.860	Rejected

If the calculated value of chi-square is less as compared to the table value 14.067 at 5% level of significance with (8-1) = 7 degree of freedom, null hypothesis is accepted. This reveals that the overhead productivity indices of the company for the study period are approximately equal and can be represented by straight line trend or line of best fit.

If the calculated value of chi-square is more as compared to the table value hence null hypothesis is rejected. This reveals that the overhead productivity ratios of the company for the eight year period are not the same and cannot be represented by straight line trend or line of best fit.

- **Overhead Productivity Ratios and Kruskal Wallis One Way Analysis of Variance Test**

The rank sum of each of the sample has been calculated and H is computed.

Table 8.8

Overhead Productivity Ratios and Kruskal Wallis One Way Analysis of Variance Test

S. No.	Sector Name	H Value	Null Hypothesis Testing
1	Automobile Sector	26.045	Rejected
2	Energy Sector	28.102	Rejected
3	Information Technology Sector	24.821	Rejected
4	Metals Sector	22.366	Rejected
5	Pharmaceutical Sector	12.435	Rejected
6	Refineries Sector	16.395	Rejected

As the calculated value of H is greater than the table value 7.815 at 5% level of significance with (4-1) = 3 degrees of freedom in the entire above cases hence null hypothesis is rejected. This means that the overhead productivity ratios are not same that is there is a difference in the overhead productivity ratios.

- **Suggestions for Improvement**

Overhead productivity can be improved by reducing the expenses in overhead cost. Overhead cost such as electricity expenses can be reduced by avoiding the wastage of it. Management should take steps to reduce the selling and distribution cost so as to attain higher productivity. By reducing the cost it ultimately increases the productivity and hence the company becomes more productive.

8.7. Chapter 7: Overall Productivity

Overall productivity is based on the overall inputs which are the sum of all inputs taken together viz., material, labour, overhead and investor input. Investor input has been calculated on the basis of average investments.

- **Steps in Measurement of Overall Productivity**

1. Revaluation of Investor Input at Base Year Prices.

- Investor input is an additional cost other than material, labour and overhead for which the company pays the cost, i.e. interest, royalty, profit, etc.

- Investor input is calculated by multiplying the base year rate of return with the average investment.

2. Calculation of Average Investment

- Investment or capital employed includes non-current assets and working capital. Non-current assets includes fixed assets (tangible fixed assets and intangible fixed assets), non-current trade investments (it is assumed that all non-current investments are trade investments unless specified to be non-trade investments), long term loans and advances. Working capital means current assets less current liabilities.
- Half of the profit has been deducted from the value of investment to obtain the average investment.
- Fixed assets have been taken on the historical values as shown in the balance sheet of the respective companies.
- Non-current investments, long term loans and advances and other non-current assets, current assets, current liabilities, profit are revalued on the basis of wholesale price index.

3. Calculation of Base Year Rate of Return.

- Total cost has been deducted from the output to obtain the base year returns. Total cost includes material cost, labour cost and overhead cost. Sector wise rate of return has been calculated by dividing the base year return with the average investment.
- Formula for the calculation of base year rate of return has been summarized below:

$$\text{Rate of Return (company standard)} = \frac{\text{Return}}{\text{Average Investment}} \times 100$$

- The base year rate of return based on industry standard for inter-company comparison has been calculated with the help of the following formula:

$$R_I = \frac{R_1 + R_2 + R_3 + R_4}{AI_1 + AI_2 + AI_3 + AI_4} \times 100$$

Where,

R_I = Rate of Return (Industry Standard)

R_1 to R_4 = Rate of Return of Sector companies

AI_1 to AI_4 = Average Investment of Sector companies

4. Computation and Analysis of Overall Productivity Ratios and Overall Productivity Indices.

- Overall productivity ratio means output at base year prices per rupee of overall input. Overall input consists of material, labour, overhead and the investor input.
- Overall productivity indices have been calculated assuming base year overall productivity ratio as 100.

5. Testing Hypotheses

- Intra-company hypothesis has been tested through chi-square test.
- Inter-company hypothesis has been tested through kruskal wallis one way analysis of variance test.

➢ **Analysis of Average Overall Productivity Ratios**

Automobile Sector: The average overall input output ratio is the best of Bajaj Auto Ltd. by 0.8729, followed by Maruti Suzuki India Ltd. by 1.0050, Mahindra & Mahindra Ltd. by 1.0073 and lastly Tata Motors Ltd. by 1.1462. Average overall productivity ratio is the best of Bajaj Auto Ltd. with 1.1465 which means that for one ₹ of material input, the output produced is 1.1465. This is followed by Maruti Suzuki India Ltd. with 0.9957 then Mahindra & Mahindra Ltd. with 0.9931 and lastly Tata Motors Ltd. with 0.8760.

Energy Sector: The average overall input output ratio is the best of GAIL (India) Ltd. with 1.0244, followed by Oil and Natural Gas Corporation Ltd. by 1.0458, NTPC Ltd. with 1.1979 and lastly Power Grid Corporation of India Ltd. with 1.7370. Average overall productivity ratio is the best of GAIL (India) Ltd. with 0.9773, followed by Oil and Natural Gas Corporation Ltd. with 0.9678, NTPC Ltd. with 0.8390 and lastly Power Grid Corporation of India Ltd. with 0.5791.

Information Technology Sector: The average overall input output ratio is the best of Tata Consultancy Services Ltd. by 0.8658, followed by Infosys Ltd. by 0.9623, Wipro Ltd. by 1.0355 and lastly 1.0837 of Tech Mahindra Ltd. Average overall productivity ratio is the best of Tata Consultancy Services Ltd. with 1.1560, then Infosys Ltd. with 1.0397, Wipro Ltd. with 0.9668 and lastly Tech Mahindra Ltd. with 0.9256.

Metals Sector: The average overall input output ratio is the best of Coal India Ltd. by 0.2798, followed by 1.1296 of Tata Steel Ltd. then 1.1481 of Vedanta Ltd. and lastly 1.2404 of Hindalco Ltd. Average overall productivity ratio is the best of Coal India Ltd. with 4.5423 which means that for one ₹ of overall input, the output produced is approximately ₹ 5. This is followed by Vedanta Ltd., Tata Steel Ltd. and Hindalco Ltd.

Pharmaceutical Sector: The average overall input output ratio is the best of Lupin Ltd. with 0.9263, followed by Dr. Reddy's Laboratories Ltd. with 1.0460, Cipla Ltd. with 1.0521 and lastly Sun Pharmaceutical Industries Ltd. with 1.3901. Average overall productivity ratio is the best of Lupin Ltd. with1.0881, followed by Dr. Reddy's Laboratories Ltd., Cipla Ltd. and Sun Pharmaceutical Industries Ltd.

Refineries Sector: The average overall input output ratio is the best of Reliance Industries Ltd. by 0.9574, followed by 0.9827 of Bharat Petroleum Corporation Ltd., 0.9834 of Indian Oil Corporation Ltd. and lastly 0.9916 of Hindustan Petroleum Corporation Ltd. Average overall productivity ratio is the best of Reliance Industries Ltd. with 1.0450, followed by Bharat Petroleum Corporation Ltd. with 1.0183, Indian Oil Corporation Ltd. with 1.0179 and lastly Hindustan Petroleum Corporation Ltd. with 1.0091.

- **Overall Productivity and Chi-square Test**

Overall productivity of companies of six sectors included in Nifty 50 has been calculated and analysis has been drawn out of it.

Table 8.9

Chi-square Test on Overall Productivity of Companies from 2010-11 to 2017-18

S. No.	Company Name	Chi-square Value	Null Hypothesis Testing
1	Bajaj Auto Ltd.	0.159	Accepted
2	Mahindra & Mahindra Ltd.	0.171	Accepted
3	Maruti Suzuki India Ltd.	0.323	Accepted
4	Tata Motors Ltd.	2.573	Accepted
5	GAIL (India) Ltd.	0.316	Accepted
6	NTPC Ltd.	0.305	Accepted
7	Oil and Natural Gas Corporation Ltd.	0.759	Accepted
8	Power Grid Corporation of India Ltd.	3.586	Accepted

9	Infosys Ltd.	0.286	Accepted
10	Tata Consultancy Services Ltd.	0.314	Accepted
11	Tech Mahindra Ltd.	1.455	Accepted
12	Wipro Ltd.	0.627	Accepted
13	Coal India Ltd.	219.742	Rejected
14	Hindalco Ltd.	0.991	Accepted
15	Tata Steel Ltd.	1.964	Accepted
16	Vedanta Ltd.	28.625	Rejected
17	Cipla Ltd.	1.073	Accepted
18	Dr. Reddy's Laboratories Ltd.	1.682	Accepted
19	Lupin Ltd.	6.156	Accepted
20	Sun Pharmaceutical Industries Ltd.	22.234	Rejected
21	Bharat Petroleum Corporation Ltd.	0.466	Accepted
22	Hindustan Petroleum Corporation Ltd.	0.312	Accepted
23	Indian Oil Corporation Ltd.	0.612	Accepted
24	Reliance Industries Ltd.	0.385	Accepted

If the calculated value of chi-square is less as compared to the table value 14.067 hence null hypothesis is accepted. This reveals that there is no significant difference in the overall productivity indices of the company for the study period and can be represented by straight line trend or line of best fit.

If the calculated value of chi-square is more as compared to the table value 14.067 hence null hypothesis is rejected. This reveals that the overall productivity indices of the company for the study period are not same and cannot be represented by straight line trend or line of best fit.

- **Overall Productivity Ratios and Kruskal Wallis One Way Analysis of Variance Test**

The rank sum of each of the sample has been taken and H value is computed.

Table 8.10

Overall Productivity Ratios and Kruskal Wallis One Way Analysis of Variance Test

S. No.	Sector Name	H Value	Null Hypothesis Testing
1	Automobile Sector	26.185	Rejected
2	Energy Sector	23.125	Rejected
3	Information Technology Sector	26.821	Rejected
4	Metals Sector	20.909	Rejected
5	Pharmaceutical Sector	11.474	Rejected
6	Refineries Sector	5.347	Accepted

If the calculated value of H is greater than the table value 7.815 at 5% level of significance with (4-1) = 3 degrees of freedom, null hypothesis is rejected. This means that the overhead productivity ratios are not same that is there is a difference in the overhead productivity ratios.

If the calculated value is less than the table value hence null hypothesis is accepted. This means that there is no significant difference in overall productivity ratios of the companies included in Nifty 50.

- **Overall Productivity Ranking of Sampled Companies: At a Glance**

Overall productivity of all the companies of all sectors under the study are taken together and analysed. Table 8.11 states the rank is allowed to each one of them. The company having the highest productivity has been ranked first.

Table 8.11

Overall Productivity Ranking of Sampled Companies: At a Glance from 2010-11 to 2017-18

Years	2010-11		2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18		Overall	
Companies	Overall Productivity	Rank	Overall Productivity	Rank	Overall Productivity	Rank	Overall Productivity	Rank	Overall Productivity	Rank	Overall Productivity	Rank	Overall Productivity	Rank	Overall Productivity	Rank	Average	Rank
Bajaj Auto Ltd.	1.1922	3	1.1743	2	1.1613	2	1.1585	4	1.1177	4	1.1658	3	1.1048	4	1.0979	3	1.1465	3
Mahindra & Mahindra Ltd.	1.0280	10	0.9794	15	1.0163	7	0.9899	13	0.9978	10	0.9746	14	0.9695	11	0.9897	10	0.9931	11
Maruti Suzuki India Ltd.	1.0108	12	0.9665	16	0.9752	15	0.9729	15	0.9718	13	1.0123	10	1.0245	6	1.0315	9	0.9957	10
Tata Motors Ltd.	0.9260	19	0.9181	19	0.8984	18	0.8709	19	0.7647	22	0.8875	19	0.8174	20	0.9248	14	0.8760	20
GAIL (India) Ltd.	1.0522	8	0.9945	14	0.9989	12	0.9649	16	0.9518	14	0.9399	16	0.9514	13	0.9650	12	0.9773	12
NTPC Ltd.	0.9147	21	0.9052	21	0.9037	17	0.8595	20	0.8015	21	0.7785	22	0.7869	21	0.7622	22	0.8390	21
Oil and Natural Gas Corporation Ltd.	1.1344	4	1.1288	5	1.0145	8	0.9756	14	0.8891	18	0.8949	18	0.8514	18	0.8536	18	0.9678	13
Power Grid Corporation of India Ltd.	0.6552	24	0.6085	24	0.5824	23	0.5290	24	0.5085	24	0.5541	24	0.5956	24	0.5993	24	0.5791	24
Infosys Ltd.	1.0240	11	1.0497	7	1.0120	9	1.0181	7	1.0537	6	1.0683	6	1.0204	7	1.0712	5	1.0397	6
Tata Consultancy Services Ltd.	1.0927	6	1.1494	3	1.1158	3	1.1746	3	1.1739	2	1.1990	2	1.1540	2	1.1887	2	1.1560	2
Tech Mahindra Ltd.	0.8792	22	0.8415	22	0.8766	20	0.9912	12	0.9444	15	0.9890	13	0.9380	15	0.9448	13	0.9256	18
Wipro Ltd.	0.9168	20	0.9136	20	0.9768	14	1.0054	9	0.9931	11	0.9907	12	0.9602	12	0.9776	11	0.9668	14
Coal India Ltd.	1.5708	1	2.7146	1	3.0637	1	6.3331	1	5.3559	1	7.1470	1	6.3928	1	3.7608	1	4.5423	1
Hindalco Ltd.	0.8679	23	0.8398	23	0.7977	21	0.7528	22	0.8198	19	0.7983	21	0.7702	22	0.8152	21	0.8077	22
Tata Steel Ltd.	0.9655	15	0.9520	18	0.8921	19	0.9032	18	0.8056	20	0.8387	20	0.8284	19	0.9247	15	0.8888	19
Vedanta Ltd.	1.5113	2	1.1426	4	0.5344	24	0.7780	21	0.8897	17	0.9735	15	0.8813	17	0.8296	20	0.9426	17
Cipla Ltd.	0.9552	17	1.0038	12	0.9684	16	0.9632	17	0.8904	16	1.0055	11	0.9122	16	0.9185	16	0.9522	16
Dr. Reddy's Laboratories Ltd.	0.9516	18	0.9656	17	1.0173	6	1.0297	6	0.9882	12	0.9338	17	0.9422	14	0.8449	19	0.9592	15
Lupin Ltd.	1.0624	7	1.0054	11	1.0725	4	1.2367	2	1.1477	3	1.1628	4	1.1092	3	0.9083	17	1.0881	4
Sun Pharmaceutical Industries Ltd.	1.1008	5	1.1226	6	0.7504	22	0.5745	23	0.6008	23	0.5905	23	0.6430	23	0.7490	23	0.7664	23
Bharat Petroleum Corporation Ltd.	0.9896	14	1.0058	10	1.0051	11	1.0037	10	1.0622	5	1.0542	7	0.9871	9	1.0385	8	1.0183	7
Hindustan Petroleum Corporation Ltd.	0.9631	16	0.9994	13	1.0102	10	0.9992	11	1.0461	8	1.0221	9	0.9924	8	1.0404	7	1.0091	9
Indian Oil Corporation Ltd.	0.9932	13	1.0141	9	0.9889	13	1.0065	8	1.0409	9	1.0474	8	0.9745	10	1.0774	4	1.0179	8
Reliance Industries Ltd.	1.0370	9	1.0410	8	1.0221	5	1.0372	5	1.0463	7	1.1041	5	1.0255	5	1.0465	6	1.0450	5

According to the table 8.11, overall productivity is the best in Coal India Ltd., followed by Vedanta Ltd. and Bajaj Auto Ltd. in 2010-11. Coal India Ltd. is the

best in 2011-12 and 2012-13, followed by Bajaj Auto Ltd. and Tata Consultancy Services Ltd. In 2013-14, Coal India Ltd. marked as the best performer related to the productivity, followed by Lupin Ltd. and Tata Consultancy Services Ltd. In 2014-15 and 2016-17, Coal India Ltd. ranked the best, followed by Tata Consultancy Services Ltd. and Lupin Ltd. In 2015-16 and 2017-18, Coal India Ltd. ranked first, followed by Tata Consultancy Services Ltd. and Bajaj Auto Ltd.

By analysing the overall productivity of all companies during eight years of study period, it has been observed that overall productivity is the best in Coal India Ltd., followed by Tata Consultancy Services Ltd. and Bajaj Auto Ltd.

8.8. Policy Recommendations

Following are the recommendations based on the observation during the study:

1. The companies should adopt recent techniques of costing such as Activity Based Costing system (ABC) for pricing its product as they are more appropriate and helpful in reducing the cost. It is the collection of financial operations and performance information, determining the significant activities of the organisation to take steps for reducing the cost and ultimately increasing the productivity.
2. The company should take steps towards green productivity. It is a strategy adopted to improve productivity as well as environmental performance resulting in the socio-economic development of the country. Its methodology comprises of the adoption of appropriate techniques, technologies and management system that can produce the eco-friendly goods and services.
3. Sometimes, due to the nature of raw material and production process a company may create the problem of polluted environment. To overcome this problem companies should plan layouts with green lawns, plants, gardens, fountains, etc. to create a better environment for improvement in environmental productivity.
4. To improve the work force productivity a company should promote leisure or recreational activities which are mainly categorized as physical, social, cultural and intellectual activities. These activities include sports, games,

vacation, family get together, creating clubs for employees entertainment and encouraging them to join, etc.

5. Zero Base Budgeting technique can also be used for improving the productivity in an organisation. This technique assists in justifying each and every expense before incorporating it to the main budget. The rational behind this is to reduce expenditure and seeking the areas where cost can be minimized.
6. Total Quality management can also be applied for improving the organizational productivity. It is a management system for a customer focused organisation according to which a quality discipline culture is adopted in the activities of the organisation.
7. An organisation can also improve its productivity by adopting Business Process Reengineering (BPR) technique. It is fundamentally rethinking and radical redesign of process to achieve dramatic improvement in critical and contemporary measures of performance such as cost, quality, service and speed.
8. Management by objective is also an innovative technique according to which individuals goals are integrated with the organisation goals. A link is created between the organizational goals and individual's target so that each and every employee is able to know how his individual work contributes to the goals of the organisation. Employee participation in goal setting, actions implementation and in reviewing performance provides a good measure of self- control by an individual. As a result of it there is an improvement in the understanding, motivation and morale of the individual, results in productivity enhancement.
9. Automation technique is adopted by using automatic and smart machines at the work place. This will reduce time of processing and also products are of qualitative and standardized one.
10. An organisation profitability and productivity is mainly governed by the five forces namely threat of new entrants, bargaining power of customers, bargaining power of suppliers, rivalry among current players in the competitive environment and lastly threats from substitutes. A company has to

give due weightage to each of these forces in order to reach to the maximum profit by optimizing cost and allocation of cost in accordance with the effect of forces on companies business thus improving productivity.

11. The organisation managers can also take the help of SWOT analysis for maximizing its output with the optimum use of input, leads to increased profitability and ultimately results in improvement in productivity. Managers competitively analysis strength, weaknesses, opportunity and threat of the organisation that can be an edge over the other companies.
12. Manufacturing companies can also adopt the critical path method (CPM) for planning the production process. It is the program developed to track all the elements which are involved in the production process as this method determines the time duration for an activity of production to conclude. With the help of this an organisation can check the machine workload and its idle time and can also analyse its capacity time in which goods can be delivered and plan companies selling and marketing strategies accordingly.
13. Measurement of productivity is regarded as an essence in the survival of an organisation, yet it is not disclosed by the companies in their financial statements. The companies should disclose in its financial statements to depict a true and fair picture of the company in respect of utilisation of resources, as these resources are scarcely available in the society, so its optimum utilisation is the need of the hour.
14. A company should adopt the productivity audit concept. According to which productivity audit should be conducted at regular interval of time. This will ensure that the resources are being optimally utilised.

8.9. Limitations of the Study

All studies have their own limitations therefore this study has no exception as such. This study also suffers from some limitations which are being summarized here under:

1. The study includes some selected companies of Nifty 50 only.
2. The study does not consider the productivity of financial institution, banking, telecommunication companies, etc.

3. The study is restricted to a period of eight years only i.e. from 2010-11 to 2017-18 due to the limitation of time.
4. The study is limited to India only and with some selected years for study, if some developing and developed countries have also been included in the study the results drawn out may get influenced.
5. While calculating the material productivity, material input information is not available in case of two companies that are Power Grid Corporation of India Ltd. and Tech Mahindra Ltd. Power Grid Corporation of India Ltd. is the company engaging in transmission of electricity. So the revenue generated and all the other expenses in the financial statements of the company are related to the transmission only while Tech Mahindra Ltd. is specialist in digital transformation, consulting and business re- engineering solutions. So element of material is not there in its financial statements due to this material productivity and chi-square test could not be calculated. Hence, these companies are being ignored while applying the kruskal wallis one way analysis of variance test also.
6. Some more aspects of productivity such as capital productivity, productivity in terms of value added, machine productivity, etc. could also be measured. But due to limitation of time and non availability of data this could not be included in the study.

8.10. Further Scope for the Research

By keeping in mind the above limitations the further scope for future researchers can be enumerated as follows:

1. This study is based on the productivity of selected sector companies included in Nifty 50 only. More study can also be possible on companies of BSE Sensex, Nifty 100, etc.
2. Future researches can be done by considering other factors such as capital productivity, productivity based on value added, etc.
3. In the present research, Productivity Accounting Model propogated by H. S. Davis has been used. Other models can also be used to measure the productivity of the concern and researches can be done on these models.

4. Future researches can be conducted, in the field of service sector companies such as tourism, port services, storage services, etc.
5. Banks and Financial sectors productivity can also be calculated and analysed by the researchers in future.

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- **Journal Articles and Dissertations**
- **Websites and Web Links**
- **Reports**

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Published Papers in UGC Referred Journals

LIST OF PUBLISHED PAPERS IN UGC REFERRED JOURNALS

S. No.	Paper Title	Journal Name	Journal Type	ISSN No.	Volume/ Issue No.	Page Nos.	Month & Year of Publication
1	Labour Productivity in Energy Sector Companies included in Nifty 50: An Empirical Study	Pacific Business Review International	UGC CARE List Journal Group II-Web of Science	0974-438X	Accepted	-	-
2	Measuring Labour Productivity in Refineries Sector Companies included in Nifty 50	Indian Journal of Accounting	Peer-reviewed Refereed Journal	P-ISSN: 0972-1479, E-ISSN 2395-6127	Accepted	-	-
3	Analysis of Productivity: A Comparative Study of Pharmaceutical Sector Companies included in Nifty 50	Productivity Journal	Refereed Journal	E-ISSN: 0976 3902 ISSN: 0032-9924	Accepted	-	-
4	Productivity Measurement Using Productivity Accounting Model: A Case Study of Refineries sector Companies included in Nifty 50	The Management Accountant	Refereed Journal	0972-3528	Volume 55, Issue 7	103-111	July, 2020
5	Measuring Productivity in IT Sector Companies included in Nifty 50: An Empirical Study	IITM Journal of Business Studies (JBS)	A UGC CARE Approved Journal	2393-9451	Volume 7, Issue 1	185-197	January - December, 2020
6	Measurement of Material Productivity: A Case Study of Pharmaceutical Sector Companies included in Nifty 50	Productivity Journal	Refereed Journal	E-ISSN: 0976 3902 ISSN: 0032-9924	Volume 60, Issue 2	175-194	July - September, 2019
7	Measurement of Material Productivity: A Case Study of Automobile Sector Companies included in Nifty 50	International Journal of Research and Analytical Reviews (IJRAR)	UGC Approved, Peer-reviewed Refereed Journal (Journal No. 43602)	E-ISSN: 2348-1269, P-ISSN 2349-5138	Volume 6, Issue 2	964-981	June, 2019
8	Productivity Accounting : A Review of Literature	INSPIRA-Journal of Commerce, Economics and Computer Science	Peer-reviewed Refereed Journal	2395-7069	Volume 1, Issue 4	68-76	October-December, 2015

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PRODUCTIVITY MEASUREMENT USING PRODUCTIVITY ACCOUNTING MODEL: A CASE STUDY OF REFINERIES SECTOR COMPANIES INCLUDED IN NIFTY 50

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Abstract

Research Issue: *Productivity is the relationship between output and one or more of the physical or monetary inputs used in the production process. It is denoted as a ratio of monetary value of output to the monetary value of input. In the present research, an attempt has been made to measure, analyse and compare intra company and inter company productivity of Refineries sector companies from 2010-11 to 2017-18 i.e. for eight years.*

Research Findings: *Intra company comparison has been drawn with the help of chi- square test and results indicate that hypothesis drawn is accepted in all the cases of refineries sector companies. This means that the overall productivity indices of the Refineries sector companies for the study period are approximately same and can be represented by straight line trend or line of best fit. Inter company comparison has been drawn with the help of Kruskal Wallis One Way Analysis of Variance Test and results indicate that null hypothesis isaccepted which means that there is no significant difference in the overall productivity ratios of the companies.*

Introduction

Productivity serves as the benchmark to ascertain the efficiency of any type of organisation. As efficiency should get reflected in productivity measures, it can be considered as an effective proxy for efficiency. According to International labour organisation, "the basic principal of productivity is to make the best use of limited factors of production, like- land, capital, labour, raw material and management etc. so that maximum production becomes possible on to minimum economic and social costs."

The most integral purpose of the productivity analysis are comparing an enterprise with its competitors, determining the relative performance of the department and workers and comparing relative benefits of various types of inputs for collective bargaining and gain sharing.

Productivity is the relationship between output, may it be a physical or measured in monetary terms and one or more of the physical or monetary inputs used in the production process. It is expressed as a ratio to reflect how efficiently resources are used in creating outputs. Hence, this study aims to measure productivity in terms of material, labour, overheads and in aggregate.

Review of Literature

Many studies on productivity trends in India and abroad have been carried out over the last few decades. Few studies are being summarised below:

Reddy and Naidu (2013) in their research paper studied the productivity trends of 12 Indian cement companies for the period from 2000 to 2009. The labour, capital productivity, capital intensity, labour, capital productivity indices and capital intensity indices have been calculated to determine the efficiency of an individual factor input.

Deb and Ray (2014) have analysed in their paper total factor productivity growth in Indian manufacturing sector. The paper compares the pre and post reform performances of Indian manufacturing related to total factor productivity growthfrom1970-71 to 2007-08.

Maheshwari and Taparia (2019)investigated in their paper the material productivity of automobile sector companies included in Nifty 50. The study analysed the material productivity of eight years from 2010-11 to 2017-18.

Research Gap: As per the above reviews and many more studies studied related to the topic, there is no study on productivity of refineries sector companies included in Nifty 50 for this particular study period and by measurement of productivity by productivity accounting model.

Research Methodology

Main Objectives of the Research

The main objectives are being summarized as follows:-

1. To measure, analyse and compare the intra company and inter company overall including material, labour and overhead productivity.
2. To suggest ways for the improvement in material, labour, overhead and overall productivity.

Sample and Collection of Data

This research is based on the secondary data. The data and informationhave been obtained from the annual reports of theselectedsampled refineriessector companies viz., BPCL, HPCL, IOCL, RIL included in Nifty 50.The index numbersused in the study have been collected from the various bulletins published by Reserve Bank of India on its website.

Selection of Base Year

The study covers a period of eight years i.e. from 2010-11 to 2017-18. The year 2010-11 has been taken as the base year. The revaluation of output and input is done as per the base year.

Model to be used

In the present research, Productivity Accounting Model has been used for measuring productivity because it considers all the elements of output and input, ignoring the effect of inflation.

Hypotheses

Keeping in mind the objectives of the research, following hypotheses have been developed and tested.

Intra Company Comparison- Non Parametric Chi-Square Test

Null Hypothesis (H_0): There is no significant difference in the material, labour, overhead and overall productivity indices of the sampled company for the study period and can be represented by straight line trend or line of best fit.

Inter Company Comparison- Kruskal Wallis One Way ANOVATest

Null Hypothesis (H_0): There is no significant difference in the material, labour, overhead and overall productivity ratios of sampled companies.

Calculation of Index Numbers and Conversion Factors

Index numbers published by various RBI Bulletins and conversion factors accordingly have been used,forthe revaluation of data on the base year's prices for eight years from 2010-11 to 2017-18.Here the year 2010-11 has been taken as base year. Backward Splicing technique has been used for calculating the index numbers of 2010-11.

Following formula has been used to calculate conversion factors:

Index number of the base year

Index number for the current year

Table 1: Index Numbers and the Conversion Factors for Revaluation of Data

Year	Wholesale Price Index Base year 2011-12 = 100	Conversion Factors	Consumer Price Index for Industrial Workers Base Year 2001 = 100	Conversion Factors	Fuel and Power Index Base Year 2011-12 = 100	Conversion Factors
2010-11	91.80	1.000	180.00	1.000	87.75	1.000
2011-12	100.00	0.918	195.00	0.923	100.00	0.878
2012-13	106.90	0.859	215.00	0.837	107.10	0.819
2013-14	112.50	0.816	236.00	0.763	114.70	0.765
2014-15	113.90	0.806	251.00	0.717	107.70	0.815
2015-16	109.70	0.837	265.00	0.679	86.50	1.014
2016-17	111.60	0.823	276.00	0.652	86.30	1.017
2017-18	114.90	0.799	284.00	0.634	93.30	0.941

Source: *Authors Calculation with the help of RBI Bulletin*

Revaluation of Output

The output of the companies has been revalued by multiplying the output values with the conversion factors based on wholesale price index. Output includes sales, other income and change in the inventories of finished goods, work in progress and traded goods.

Revaluation of Input

The respective input values have been revalued bymultiplying the input values with the conversion factors.

Labour- revalued by Consumer Price Index,

Power and Fuel- by Fuel and Power Index

Rest of the Cases- by Wholesale Price Index

Depreciation and Amortisation-Not revalued.

In the present research assets approach is followed for calculating the capital employed or investment. Fixed assets have been taken on the historical values as shown in the balance sheet of the respective company.

Base Year Rate of Return: The base year rate of return based on industry standard for intercompany comparison has been calculated with the help of the following formula:

$$R_I = \frac{R_1 + R_2 + R_3 + R_4 \text{(Rate of Return of Sector Companies)}}{AI_1 + AI_2 + AI_3 + AI_4 \text{(Average Investment of Sector Companies)}} X100 = 5.55\%$$

Productivity: Productivity indicates that how much has been produced as output by a unit of input. It has been shown inAppendices.

Table 2: Hypothesis Testing and Interpretation of Productivity

Company	Table Value	Material Productivity		Labour Productivity		Overhead Productivity		Overall Productivity	
		Chi Square Value	Result (Null Hypothesis)	Chi Square Value	Result (Null Hypothesis)	Chi Square Value	Result (Null Hypothesis)	Chi Square Value	Result (Null Hypothesis)
Bharat Petroleum Corporation Ltd.	14.067	0.650	Accepted	69.482	Rejected	6.302	Accepted	0.368	Accepted
Hindustan Petroleum Corporation Ltd.	14.067	0.353	Accepted	32.335	Rejected	9.032	Accepted	0.312	Accepted
Indian Oil Corporation Ltd.	14.067	0.575	Accepted	33.676	Rejected	8.073	Accepted	0.612	Accepted
Reliance Industries Ltd.	14.067	2.918	Accepted	19.682	Rejected	23.860	Rejected	0.385	Accepted

If the calculated value of chi square is less as compared to the table value hence null hypothesis is accepted. This reveals that the productivity indices of the company for the study period are approximately equaland can be represented by straight line trend or line of best fit.

Kruskal Wallis One Way ANOVA Test

The productivity of all the samples is combined and arranged in increasing order, given a rank number and value of H is calculatedand result indicated in table 3.

Table 3: Kruskal Wallis One Way ANOVATest of Refineries Sector

Particulars	H Value	Table Value	Result
Material Productivity Ratios from 2010-11 to 2017-18	17.739	7.815	Null hypothesis is Rejected
Labour Productivity Ratios from 2010-11 to 2017-18	11.514	7.815	Null hypothesis is Rejected
Overhead Productivity Ratios from 2010-11 to 2017-18	16.395	7.815	Null hypothesis is Rejected
Overall Productivity Ratios from 2010-11 to 2017-18	6.352	7.815	Null hypothesis is Accepted

The null hypothesis is rejected by applying H Test on material, labour, overhead productivity ratios while it is accepted in case of overall productivity ratios. This means that there is a significant difference in material, labour, overhead productivity ratios of the refineries sector companies whilethere is no significant difference in overall productivity ratios of the refineries sector companies of Nifty 50.

Possible Savings

Possible savings has been calculated to analyse what would have been saved if optimum utilisation of resources is made.

Possible Saving in input = Actual input – Standard input

Standard input = minimum requirement of Input per unit of output X Actual Output revalued according to the base year.

Table 4: Possible Savings from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bharat Petroleum Corporation Ltd.			Hindustan Petroleum Corporation Ltd.			Indian Oil Corporation Ltd.			Reliance Industries Ltd.		
		Material	Labour	Overhead	Material	Labour	Overhead	Material	Labour	Overhead	Material	Labour	Overhead
2010-11	Standard	127605	1149	7154	114045	1117	6439	260459	3755	18436	163790	1959	19442
	Actual	141028	2803	8012	126019	1982	7035	299786	6436	18436	198076	2624	26195
	Saving	13423	1654	858	11974	865	596	39327	2681	0	34286	665	6753
2011-12	Standard	165029	1487	9252	142246	1393	8039	318399	4597	22555	203259	2431	24126
	Actual	181706	2087	9668	152954	1461	8039	362046	4597	22664	256799	2642	24594
	Saving	16677	600	416	10708	68	0	43647	0	109	53540	211	468
2012-13	Standard	174172	1569	9773	155542	1523	8782	305154	4400	21616	207077	2477	24580
	Actual	192016	2318	9773	164658	2114	8870	351690	6086	23769	266658	2807	25538
	Saving	17844	749	0	9116	591	88	46536	1686	2153	59581	330	958
2013-14	Standard	178654	1609	10016	158405	1549	8943	309459	4462	21921	215299	2571	25550
	Actual	196106	2210	10984	169305	1549	9619	346723	5050	27586	272775	2571	25550
	Saving	17452	601	968	10900	0	676	37264	588	5665	57476	0	0
2014-15	Standard	166470	1495	9333	148357	1453	8376	289216	4170	20487	180865	2163	21468
	Actual	170667	1495	11742	149845	1731	9573	310164	5094	26533	215874	2643	27952
	Saving	4197	0	2409	1488	278	1197	20948	924	6046	35009	480	6484
2015-16	Standard	135606	1222	7603	131401	1287	7419	237967	3431	16857	135406	1619	16071
	Actual	135606	1955	12701	131401	1572	12898	240796	5186	32127	135406	2893	30384
	Saving	0	733	5098	0	285	5479	2829	1755	15270	0	1274	14313
2016-17	Standard	138341	1246	7756	131488	1288	7424	229015	3302	16223	133666	1599	15866
	Actual	149883	2236	11537	138400	1921	10618	247462	6337	34148	143569	2891	30785
	Saving	11542	990	3781	6912	633	3194	18447	3035	17925	9903	1292	14919
2017-18	Standard	161548	1455	9057	153937	1508	8691	273895	3949	19402	155699	1862	18481
	Actual	165480	2175	13910	154915	1812	11681	273895	6390	31045	168328	3005	32376
	Saving	3932	720	4853	978	304	2990	0	2441	11643	12629	1143	13895
Total Savings		85067	6047	18384	52075	3024	14221	208996	13110	58811	262423	5394	57790

Note: Amount has been rounded off to nearest ₹

Above table suggests that the total possible savings in material input for a period of eight years would have been ₹ 85067 crore of BPCL, ₹ 52075 crore of HPCL, ₹ 208996 crore of IOCL and lastly ₹ 262423 crore of RIL.The total savings in labour input for a period of eight years would have been ₹ 6047 crore of BPCL with 2014-15 as a base year, ₹ 3024 crore of HPCL with 2013-14 as a base year, ₹ 13110 crore of IOCL with 2011-12 as a base year and lastly ₹ 5394 crore of RIL with 2013-14 as a base year. The total savings in overhead input for a period of eight years would have been ₹ 18384 crore of BPCL, ₹ 14221 crore of HPCL, ₹ 58811 crore of IOCL and lastly ₹ 57790 crore of RIL.

Comparative Average Analysis

To analyse between the companies of a particular sector it is better to analyse its average performance for the study period.

Table 5: Comparative Average Productivity Ratios from 2010-11 to 2017-18

Base Year 2010-11

Companies	Total Material (Input Output Ratio)		Material Productivity Ratio		Total Labour (Input Output Ratio)		Labour Productivity Ratio		Total Overhead (Input Output Ratio)		Overhead Productivity Ratio		Overall Input Output Ratio		Overall Productivity Ratio	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank
Bharat Petroleum Corporation Ltd.	0.9006	3	1.112	3	0.0120	3	88.513	3	0.0604	2	17.118	2	0.9877	3	1.013	3
Hindustan Petroleum Corporation Ltd.	0.9088	4	1.102	4	0.0110	2	94.110	2	0.0602	1	17.162	1	0.9916	4	1.009	4
Indian Oil Corporation Ltd.	0.8700	2	1.153	2	0.0165	4	63.130	4	0.0796	3	13.489	3	0.9834	2	1.018	2
Reliance Industries Ltd.	0.7741	1	1.302	1	0.0109	1	96.546	1	0.1106	4	9.676	4	0.9574	1	1.045	1

The total material average input output ratio and average material productivity ratio is the best of RIL, followed by IOCL, BPCL and lastly HPCL.The total labour average input output ratio and average labour productivity ratio is the best of RILfollowed byHPCL,BPCLand lastly IOCL The total overhead average input output ratio and average overhead productivity ratio is the best of HPCLfollowed byBPCL, IOCL and lastly RILThe average overall input output ratio and average overall productivity ratio is the best of RILfollowed byIOCL, BPCLand lastly HPCL

Conclusion

It may be concluded from the above analysis that the refineries sector companies included in Nifty 50 are able to utilize its resources efficiently as for each amount of input more amount of output is obtained. But this should not be the only criteria for analyzing the productivity. Material productivity may increase by optimally utilizing its raw material without any wastage or spoilage, technology used in processing the material should be of high quality so that there is low wastage of material, use of good quality equipment, etc. The labour cost can be optimally utilised by adopting techniques such as incentive schemes, workers participation in the management, job enrichment, flexitime, etc. Overhead productivity can be improved by reducing the expenses in overhead cost. Overhead cost such as power and fuel expenses can be reduced by avoiding the wastage and optimally utilising it. By reducing the cost it ultimately increases the productivity and hence the company becomes more productive. MA

Appendices

1: Material Productivity of BPCL

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	151243.98	195601.15	206438.48	211751.09	197308.95	160737.40	163969.29	191476.02
2	Raw Material and Components (₹ in Crore)	62869.68	78690.25	83879.68	89240.03	76227.25	51225.12	55870.33	65235.11
3	Raw Material and Components (Input Output Ratio)	0.4157	0.4023	0.4063	0.4214	0.3863	0.3187	0.3407	0.3407
4	Stores and Spares (₹ in Crore)	53.25	53.64	57.24	53.31	96.40	68.43	9.48	0.00
5	Stores and Spares (Input Output Ratio)	0.0004	0.0003	0.0003	0.0003	0.0005	0.0004	0.0001	-
6	Purchases of Traded Goods (₹ in Crore)	78105.10	102962.10	108079.04	106812.66	94343.68	84312.68	94003.13	100244.72
7	Purchases of Traded Goods(Input Output Ratio)	0.5164	0.5264	0.5235	0.5044	0.4782	0.5245	0.5733	0.5235
8	Total Material Input (₹ in Crore)	141,028.03	181,705.99	192,015.96	196,106.00	170,667.32	135,606.24	149,882.95	165,479.84
9	Total Material (Input Output Ratio)	0.9325	0.9290	0.9301	0.9261	0.8650	0.8437	0.9141	0.8642
10	Material Productivity Ratio	1.0724	1.0765	1.0751	1.0798	1.1561	1.1853	1.0940	1.1571
11	Material Productivity Indices/ Observed Indices (O)	100.00	100.38	100.25	100.68	107.80	110.53	102.01	107.89
12	Computed Value /Expected Values (E)	99.47	100.68	101.88	103.09	104.30	105.50	106.71	107.92
13	Chi-Square $(O-E)^2/E$	0.0028	0.0009	0.0262	0.0561	0.1178	0.2392	0.2071	0.0000

Average Material Productivity Indices=103.69, a=103.69, b=0.60, χ^2=0.650, S.D.=4.02, C.V=3.88%.

2: Material Productivity of HPCL

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	131403.70	163897.08	179216.63	182515.82	170937.91	151402.12	151501.59	177367.29
2	Raw Material and Components (₹ in Crore)	40505.43	52440.66	54431.16	50735.36	45450.21	34159.34	37148.29	40897.85
3	Raw Material and Components (Input Output Ratio)	0.3083	0.3200	0.3037	0.2780	0.2659	0.2256	0.2452	0.2306
4	Stores and Spares (₹ in Crore)	116.66	111.45	134.34	136.93	196.83	193.05	243.79	195.23
5	Stores and Spares (Input Output Ratio)	0.0009	0.0007	0.0007	0.0008	0.0012	0.0013	0.0016	0.0011
6	Purchases of Traded Goods (₹ in Crore)	85396.86	100402.33	110092.82	118432.57	104198.36	97048.84	101008.22	113822.14
7	Purchases of Traded Goods (Input Output Ratio)	0.6499	0.6126	0.6143	0.6489	0.6096	0.6410	0.6667	0.6417
8	Total Material Input (₹ in Crore)	126,018.95	152,954.44	164,658.33	169,304.86	149,845.39	131,401.22	138,400.31	154,915.22
9	Total Material (Input Output Ratio)	0.9590	0.9332	0.9188	0.9276	0.8766	0.8679	0.9135	0.8734
10	Material Productivity Ratio	1.0427	1.0715	1.0884	1.0780	1.1408	1.1522	1.0947	1.1449
11	Material Productivity Indices/ Observed Indices (O)	100.00	102.76	104.38	103.39	109.40	110.50	104.98	109.80
12	Computed Value /Expected Values (E)	101.32	102.55	103.79	105.03	106.27	107.51	108.75	109.99
13	Chi-Square $(O-E)^2/E$	0.0171	0.0004	0.0033	0.0258	0.0922	0.0831	0.1306	0.0003

Average Material Productivity Indices=105.65, a=105.65, b=0.62, χ^2=0.353, S.D.=3.58, C.V.=3.38%.

3: Material Productivity of IOCL

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	326553.94	399196.39	382590.88	387987.09	362608.32	298354.22	287130.68	343394.88
2	Raw Material and Components (₹ in Crore)	143241.25	186045.37	189137.57	185614.76	165854.80	119447.64	129523.77	151158.94
3	Raw Material and Components (Input Output Ratio)	0.4386	0.4660	0.4944	0.4784	0.4574	0.4004	0.4511	0.4402
4	Stores and Spares (₹ in Crore)	833.64	823.73	904.21	978.67	1216.53	1130.96	1133.11	1194.62
5	Stores and Spares (Input Output Ratio)	0.0026	0.0021	0.0024	0.0025	0.0034	0.0038	0.0039	0.0035
6	Purchases of Traded Goods (₹ in Crore)	155710.85	175176.81	161648.51	160129.51	143092.32	120217.31	116804.68	121541.92
7	Purchases of Traded Goods(Input Output Ratio)	0.4768	0.4388	0.4225	0.4127	0.3946	0.4029	0.4068	0.3539
8	Total Material Input (₹ in Crore)	299,785.74	362,045.91	351,690.29	346,722.95	310,163.65	240,795.91	247,461.57	273,895.48
9	Total Material (Input Output Ratio)	0.9180	0.9069	0.9192	0.8936	0.8554	0.8071	0.8618	0.7976
10	Material Productivity Ratio	1.0893	1.1026	1.0879	1.1190	1.1691	1.2390	1.1603	1.2537
11	Material Productivity Indices/ Observed Indices (O)	100.00	101.22	99.87	102.73	107.33	113.75	106.52	115.10
12	Computed Value /Expected Values (E)	98.38	100.50	102.63	104.75	106.88	109.00	111.12	113.25
13	Chi-Square $(O-E)^2/E$	0.0267	0.0051	0.0742	0.0391	0.0019	0.2068	0.1907	0.0302

Average Material Productivity Indices=105.81, a=105.81, b=1.06, χ^2=0.575, S.D.=5.61, C.V.=5.30%.

4: Material Productivity of RIL

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	247978.66	307735.63	313516.10	325963.44	273830.44	204990.51	202371.59	235728.97
2	Raw Material and Components (₹ in Crore)	193233.88	252279.25	262963.09	268719.41	206334.39	127867.65	135177.75	158225.17
3	Raw Material and Components (Input Output Ratio)	0.7792	0.8198	0.8388	0.8244	0.7535	0.6238	0.6680	0.6712
4	Stores and Spares (₹ in Crore)	3378.02	3196.48	3263.34	3627.94	3789.81	3988.31	4143.81	4295.42
5	Stores and Spares (Input Output Ratio)	0.0136	0.0104	0.0104	0.0111	0.0138	0.0195	0.0205	0.0182
6	Purchases of Traded Goods (₹ in Crore)	1464.31	1322.84	431.22	427.58	5750.00	3549.72	4247.50	5807.13
7	Purchases of Traded Goods (Input Output Ratio)	0.0059	0.0043	0.0014	0.0013	0.0210	0.0173	0.0210	0.0246
8	Total Material Input (₹ in Crore)	198,076.21	256,798.57	266,657.65	272,774.93	215,874.20	135,405.68	143,569.06	168,327.73
9	Total Material (Input Output Ratio)	0.7988	0.8345	0.8505	0.8368	0.7883	0.6605	0.7094	0.7141
10	Material Productivity Ratio	1.2519	1.1984	1.1757	1.1950	1.2685	1.5139	1.4096	1.4004
11	Material Productivity Indices/ Observed Indices (O)	100.00	95.72	93.91	95.45	101.32	120.92	112.59	111.86
12	Computed Value /Expected Values (E)	93.38	96.40	99.43	102.46	105.49	108.51	111.54	114.57
13	Chi-Square $(O-E)^2/E$	0.4697	0.0049	0.3064	0.4793	0.1645	1.4195	0.0099	0.0640

Average Material Productivity Indices=103.97, a=103.97, b=1.51, χ^2=2.918, S.D.=9.28, C.V.=8.92%.

5: Labour Productivity of BPCL

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	151243.98	195601.15	206438.48	211751.09	197308.95	160737.40	163969.29	191476.02
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	1507.28	1552.71	1793.44	1657.02	1002.20	1395.67	1473.49	1594.03
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0100	0.0079	0.0087	0.0078	0.0051	0.0087	0.0090	0.0083
4	Contribution to Provident and Other Funds (₹ in Crore)	969.09	252.80	276.70	251.32	163.00	289.51	523.55	239.54
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0064	0.0013	0.0013	0.0012	0.0008	0.0018	0.0032	0.0013
6	Employees Welfare Expenses and Others (₹ in Crore)	326.48	281.46	247.41	301.57	330.18	269.70	238.96	341.66
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0022	0.0014	0.0012	0.0014	0.0017	0.0017	0.0015	0.0018
8	Total Labour Input (₹ in Crore)	2802.85	2086.97	2317.54	2209.92	1495.38	1954.87	2236.01	2175.24
9	Total Labour (Input Output Ratio)	0.0185	0.0107	0.0112	0.0104	0.0076	0.0122	0.0136	0.0114
10	Labour Productivity Ratio	53.9608	93.7251	89.0764	95.8187	131.9461	82.2239	73.3313	88.0252
11	Labour Productivity Indices / Observed Indices (O)	100.00	173.69	165.08	177.57	244.52	152.38	135.90	163.13
12	Computed Value/ Expected Values (E)	152.29	155.65	159.00	162.36	165.71	169.06	172.42	175.77
13	Chi-Square $(O-E)^2/E$	17.9553	2.0920	0.2321	1.4259	37.4832	1.6472	7.7361	0.9098

Average Labour Productivity Indices=164.03, a=164.03, b=1.68, χ^2=69.482, S.D.=38.38, C.V.=23.40%.

6: Labour Productivity of HPCL

S.No	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	131403.70	163897.08	179216.63	182515.82	170937.91	151402.12	151501.59	177367.29
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	1246.26	1011.76	1402.58	1169.68	1242.32	1111.40	1294.88	1453.77
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0095	0.0062	0.0078	0.0064	0.0073	0.0073	0.0085	0.0082
4	Contribution to Provident and Other Funds (₹ in Crore)	75.91	71.00	112.58	89.29	82.66	82.25	84.56	89.77
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0006	0.0004	0.0006	0.0005	0.0005	0.0005	0.0006	0.0005
6	Employees Welfare Expenses and Others (₹ in Crore)	659.67	378.45	598.74	290.15	406.34	377.91	541.40	268.77
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0050	0.0023	0.0033	0.0016	0.0024	0.0025	0.0036	0.0015
8	Total Labour Input (₹ in Crore)	1981.84	1461.20	2113.89	1549.12	1731.31	1571.57	1920.84	1812.30
9	Total Labour (Input Output Ratio)	0.0151	0.0089	0.0118	0.0085	0.0101	0.0104	0.0127	0.0102
10	Labour Productivity Ratio	66.3039	112.1660	84.7803	117.8191	98.7332	96.3384	78.8724	97.8685
11	Labour Productivity Indices / Observed Indices (O)	100.00	169.17	127.87	177.70	148.91	145.30	118.96	147.61
12	Computed Value/ Expected Values (E)	137.53	138.79	140.05	141.31	142.57	143.82	145.08	146.34
13	Chi-Square $(O-E)^2/E$	10.2434	6.6486	1.0600	9.3697	0.2822	0.0151	4.7051	0.0109

Average Labour Productivity Indices=141.94, a=141.94, b=0.63, χ^2=32.335, S.D.=23.97, C.V.=16.89%.

7: Labour Productivity of IOCL

S.No	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	326553.94	399196.39	382590.88	387987.09	362608.32	298354.22	287130.68	343394.88
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	3916.26	3289.91	3629.58	3858.21	3542.07	3559.49	4349.34	4803.49
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0120	0.0082	0.0095	0.0099	0.0098	0.0119	0.0151	0.0140
4	Contribution to Provident and Other Funds (₹ in Crore)	1625.57	660.18	1547.68	699.64	879.05	1202.33	1410.20	961.49
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0050	0.0017	0.0040	0.0018	0.0024	0.0040	0.0049	0.0028
6	Employees Welfare Expenses and Others (₹ in Crore)	893.72	646.50	908.80	492.42	673.00	423.76	577.19	625.36
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0027	0.0016	0.0024	0.0013	0.0019	0.0014	0.0020	0.0018
8	Total Labour Input (₹ in Crore)	6435.55	4596.60	6086.05	5050.27	5094.13	5185.58	6336.74	6390.35
9	Total Labour (Input Output Ratio)	0.0197	0.0115	0.0159	0.0130	0.0140	0.0174	0.0221	0.0186
10	Labour Productivity Ratio	50.7422	86.8461	62.8635	76.8250	71.1816	57.5353	45.3121	53.7365
11	Labour Productivity Indices / Observed Indices (O)	100.00	171.15	123.89	151.40	140.28	113.39	89.30	105.90
12	Computed Value/ Expected Values (E)	141.52	136.63	131.75	126.86	121.97	117.08	112.19	107.31
13	Chi-Square $(O-E)^2/E$	12.1821	8.7204	0.4686	4.7490	2.7490	0.1166	4.6723	0.0184

Average Labour Productivity Indices=124.41, a=124.41, b=-2.44, χ^2=33.676, S.D.=26.12, C.V.=20.99%.

8: Labour Productivity of RIL

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	247978.66	307735.63	313516.10	325963.44	273830.44	204990.51	202371.59	235728.97
2	Salary, Wages, Bonus and Benefits (₹ in Crore)	2179.21	2245.66	2448.23	2195.15	2240.63	2532.67	2535.63	2571.50
3	Salary, Wages, Bonus and Benefits (Input Output Ratio)	0.0088	0.0073	0.0078	0.0067	0.0082	0.0124	0.0125	0.0109
4	Contribution to Provident and Other Funds (₹ in Crore)	243.31	198.45	182.47	177.78	212.95	153.45	149.31	155.96
5	Contribution to Provident and Other Funds (Input Output Ratio)	0.0010	0.0006	0.0006	0.0005	0.0008	0.0007	0.0007	0.0007
6	Employees Welfare Expenses and Others (₹ in Crore)	201.65	197.52	176.61	198.38	189.29	206.42	206.03	277.69
7	Employees Welfare Expenses and Others (Input Output Ratio)	0.0008	0.0006	0.0006	0.0006	0.0007	0.0010	0.0010	0.0012
8	Total Labour Input (₹ in Crore)	2624.17	2641.63	2807.30	2571.31	2642.86	2892.54	2890.97	3005.16
9	Total Labour (Input Output Ratio)	0.0106	0.0086	0.0090	0.0079	0.0097	0.0141	0.0143	0.0127
10	Labour Productivity Ratio	94.4979	116.4948	111.6790	126.7694	103.6113	70.8687	70.0013	78.4414
11	Labour Productivity Indices / Observed Indices (O)	100.00	123.28	118.18	134.15	109.64	74.99	74.08	83.01
12	Computed Value/ Expected Values (E)	123.79	117.61	111.43	105.26	99.08	92.90	86.72	80.54
13	Chi-Square $(O-E)^2/E$	4.5727	0.2728	0.4085	7.9319	1.1269	3.4505	1.8432	0.0756

Average Labour Productivity Indices=102.17, a=102.17, b=-3.09, χ^2=19.682, S.D.=21.45, C.V.=20.99%.

9: Overhead Productivity of BPCL

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	151243.98	195601.15	206438.48	211751.09	197308.95	160737.40	163969.29	191476.02
2	Power and Fuel (₹ in Crore)	475.89	628.72	741.13	915.62	1414.94	1584.19	1331.62	1646.28
3	Power and Fuel (Input Output Ratio)	0.0031	0.0032	0.0036	0.0043	0.0072	0.0099	0.0081	0.0086
4	Depreciation and Amortisation (₹ in Crore)	1655.40	1884.87	1926.10	2246.82	2516.02	1854.30	1891.32	2648.48
5	Depreciation and Amortisation (Input Output Ratio)	0.0109	0.0096	0.0093	0.0106	0.0128	0.0115	0.0115	0.0138
6	Repairs and Maintenance (₹ in Crore)	537.51	584.61	678.83	823.21	709.67	768.00	785.73	875.35
7	Repairs and Maintenance (Input Output Ratio)	0.0036	0.0030	0.0033	0.0039	0.0036	0.0047	0.0048	0.0046
8	Business Service Input (₹ in Crore)	5342.97	6570.06	6427.37	6998.46	7101.38	8499.79	7528.43	8740.20
9	Business Service Input (Input Output Ratio)	0.0353	0.0336	0.0311	0.0331	0.0360	0.0529	0.0459	0.0456
10	Total Overhead Input (₹ in Crore)	8011.77	9668.26	9773.44	10984.12	11742.01	12701.29	11537.10	13910.31
11	Total Overhead (Input Output Ratio)	0.0530	0.0494	0.0473	0.0519	0.0595	0.0790	0.0704	0.0726
12	Overhead Productivity Ratio	18.8777	20.2313	21.1224	19.2779	16.8037	12.6552	14.2123	13.7650
13	Overhead Productivity Indices /Observed Indices (O)	100.00	107.17	111.89	102.12	89.01	67.04	75.29	72.92
14	Computed Value /Expected Values (E)	111.37	105.46	99.55	93.64	87.72	81.81	75.90	69.98
15	Chi-Square $(O-E)^2/E$	1.1615	0.0277	1.5302	0.7688	0.0190	2.6675	0.0049	0.1228

Average Overhead Productivity Indices=90.68, a=90.68, b=-2.96, χ^2=6.302, S.D.=16.02, C.V.=17.67%.

10: Overhead Productivity of HPCL

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	131403.70	163897.08	179216.63	182515.82	170937.91	151402.12	151501.59	177367.29
2	Power and Fuel (₹ in Crore)	339.56	455.60	519.81	83.77	137.67	233.34	139.18	333.45
3	Power and Fuel (Input Output Ratio)	0.0026	0.0028	0.0029	0.0005	0.0008	0.0015	0.0009	0.0019
4	Depreciation and Amortisation (₹ in Crore)	1406.95	1712.93	1983.52	2201.94	1978.76	2659.44	2535.28	2752.75
5	Depreciation and Amortisation (Input Output Ratio)	0.0107	0.0105	0.0111	0.0121	0.0116	0.0176	0.0167	0.0155
6	Repairs and Maintenance (₹ in Crore)	648.82	628.93	698.31	718.64	840.43	940.63	995.81	1088.85
7	Repairs and Maintenance (Input Output Ratio)	0.0049	0.0038	0.0039	0.0039	0.0049	0.0062	0.0066	0.0061
8	Business Service Input (₹ in Crore)	4640.11	5241.45	5668.03	6614.57	6616.61	9064.27	6948.09	7505.89
9	Business Service Input (Input Output Ratio)	0.0353	0.0320	0.0316	0.0362	0.0387	0.0599	0.0459	0.0423
10	Total Overhead Input (₹ in Crore)	7035.44	8038.91	8869.66	9618.92	9573.47	12897.69	10618.35	11680.94
11	Total Overhead (Input Output Ratio)	0.0535	0.0490	0.0495	0.0527	0.0560	0.0852	0.0701	0.0659
12	Overhead Productivity Ratio	18.6774	20.3880	20.2056	18.9747	17.8554	11.7387	14.2679	15.1843
13	Overhead Productivity Indices /Observed Indices (O)	100.00	109.16	108.18	101.59	95.60	62.85	76.39	81.30
14	Computed Value /Expected Values (E)	110.08	104.88	99.68	94.48	89.28	84.08	78.89	73.69
15	Chi-Square $(O-E)^2/E$	0.9232	0.1744	0.7247	0.5348	0.4466	5.3628	0.0789	0.7863

Average Overhead Productivity Indices=91.88, a=91.88, b=-2.60, χ^2=9.032, S.D.=15.54, C.V.=16.92%.

11: Overhead Productivity of IOCL

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	326553.94	399196.39	382590.88	387987.09	362608.32	298354.22	287130.68	343394.88
2	Power and Fuel (₹ in Crore)	1880.24	3337.93	4362.76	4753.67	4990.81	4672.38	3987.81	4494.69
3	Power and Fuel (Input Output Ratio)	0.0058	0.0084	0.0114	0.0123	0.0138	0.0157	0.0139	0.0131
4	Depreciation and Amortisation (₹ in Crore)	4546.67	4867.79	5200.99	5760.09	4528.66	4852.79	6222.97	7067.01
5	Depreciation and Amortisation (Input Output Ratio)	0.0139	0.0122	0.0136	0.0148	0.0125	0.0163	0.0217	0.0206
6	Repairs and Maintenance (₹ in Crore)	1468.63	1574.51	1738.07	2040.16	2247.67	2631.88	2468.47	2912.12
7	Repairs and Maintenance (Input Output Ratio)	0.0045	0.0039	0.0045	0.0053	0.0062	0.0088	0.0086	0.0085
8	Business Service Input (₹ in Crore)	10540.88	12883.74	12467.08	15032.50	14765.81	19969.46	21469.18	16571.00
9	Business Service Input (Input Output Ratio)	0.0323	0.0323	0.0326	0.0387	0.0407	0.0669	0.0748	0.0483
10	Total Overhead Input (₹ in Crore)	18436.42	22663.97	23768.90	27586.42	26532.94	32126.51	34148.43	31044.81
11	Total Overhead (Input Output Ratio)	0.0565	0.0568	0.0621	0.0711	0.0732	0.1077	0.1189	0.0904
12	Overhead Productivity Ratio	17.7124	17.6137	16.0963	14.0644	13.6663	9.2869	8.4083	11.0613
13	Overhead Productivity Indices /Observed Indices (O)	100.00	99.44	90.88	79.40	77.16	52.43	47.47	62.45
14	Computed Value /Expected Values (E)	102.83	95.21	87.59	79.97	72.34	64.72	57.10	49.47
15	Chi-Square $(O-E)^2/E$	0.0780	0.1881	0.1234	0.0039	0.3204	2.3333	1.6229	3.4023

Average Overhead Productivity Indices=76.15, a=76.15, b=-3.81, χ^2=8.073, S.D.=19.08, C.V.=25.06 %.

12: Overhead Productivity of RIL

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (₹ in Crore)	247978.66	307735.63	313516.10	325963.44	273830.44	204990.51	202371.59	235728.97
2	Power and Fuel (₹ in Crore)	2255.07	3594.53	5868.95	7767.05	10023.69	9874.33	10322.55	12764.67
3	Power and Fuel (Input Output Ratio)	0.0091	0.0117	0.0187	0.0238	0.0366	0.0482	0.0510	0.0541
4	Depreciation and Amortisation (₹ in Crore)	13607.58	11394.00	9465.00	8789.00	8488.00	9566.00	8465.00	9580.00
5	Depreciation and Amortisation (Input Output Ratio)	0.0549	0.0370	0.0302	0.0270	0.0310	0.0467	0.0418	0.0406
6	Repairs and Maintenance (₹ in Crore)	904.05	941.87	820.35	853.54	1014.75	1160.92	1199.93	1333.53
7	Repairs and Maintenance (Input Output Ratio)	0.0036	0.0031	0.0026	0.0026	0.0037	0.0057	0.0059	0.0057
8	Business Service Input (₹ in Crore)	9427.82	8664.08	9383.72	8140.42	8425.12	9782.86	10797.76	8697.91
9	Business Service Input (Input Output Ratio)	0.0380	0.0282	0.0299	0.0250	0.0308	0.0477	0.0534	0.0369
10	Total Overhead Input (₹ in Crore)	26194.52	24594.48	25538.02	25550.00	27951.56	30384.11	30785.24	32376.11
11	Total Overhead (Input Output Ratio)	0.1056	0.0799	0.0815	0.0784	0.1021	0.1482	0.1521	0.1373
12	Overhead Productivity Ratio	9.4668	12.5124	12.2764	12.7579	9.7966	6.7466	6.5737	7.2810
13	Overhead Productivity Indices /Observed Indices (O)	100.00	132.17	129.68	134.76	103.48	71.27	69.44	76.91
14	Computed Value /Expected Values (E)	130.62	122.51	114.39	106.27	98.16	90.04	81.92	73.81
15	Chi-Square $(O-E)^2/E$	7.1791	0.7625	2.0436	7.6386	0.2892	3.9141	1.9022	0.1306

Average Overhead Productivity Indices=102.21, a=102.21, b=-4.06, χ^2=23.860, S.D.=25.96, C.V.=25.39%.

13: Overall Productivity of BPCL

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	151243.98	195601.15	206438.48	211751.09	197308.95	160737.40	163969.29	191476.02
2	Material Input	141028.03	181705.99	192015.96	196106.00	170667.32	135606.24	149882.95	165479.84
3	Labour Input	2802.85	2086.97	2317.54	2209.92	1495.38	1954.87	2236.01	2175.24
4	Overhead Input	8011.77	9668.26	9773.44	10984.12	11742.01	12701.29	11537.10	13910.31
5	Total Input (Company Standard)	151842.65	193461.22	204106.94	209300.03	183904.71	150262.40	163656.06	181565.39
6	Normal Investor Input @ 5.55% (Industry Standard)	1155.13	1275.93	1307.79	1836.45	4278.33	4217.66	3726.87	3508.47
7	Total Input (Industry Standard)	152997.78	194737.15	205414.73	211136.48	188183.04	154480.06	167382.93	185073.86
8	Overall Input Output Ratio (Industry Standard)	1.0116	0.9956	0.9950	0.9971	0.9537	0.9611	1.0208	0.9666
9	Overall Productivity Ratio (Industry Standard)	0.9885	1.0044	1.0050	1.0029	1.0485	1.0405	0.9796	1.0346
10	Overall Productivity Indices (Industry Standard) (O)	100.00	101.61	101.66	101.45	106.07	105.26	99.10	104.66
11	Computed Value /Expected Values (E)	101.00	101.42	101.84	102.26	102.69	103.11	103.53	103.95
12	Chi-Square $(O-E)^2/E$	0.0099	0.0008	0.0008	0.0064	0.1112	0.0448	0.1899	0.0048

Average Overall Productivity Indices=102.48, a=102.48, b=0.21, χ^2=0.368, S.D.=2.38, C.V.=2.32%.

14: Overall Productivity of HPCL

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	131403.70	163897.08	179216.63	182515.82	170937.91	151402.12	151501.59	177367.29
2	Material Input	126018.95	152954.44	164658.33	169304.86	149845.39	131401.22	138400.31	154915.22
3	Labour Input	1981.84	1461.20	2113.89	1549.12	1731.31	1571.57	1920.84	1812.30
4	Overhead Input	7035.44	8038.91	8869.66	9618.92	9573.47	12897.69	10618.35	11680.94
5	Total Input (Company Standard)	135036.23	162454.56	175641.88	180472.90	161150.17	145870.48	150939.50	168408.46
6	Normal Investor Input @ 5.55% (Industry Standard)	1402.86	1539.20	1767.77	2186.55	2250.72	2259.00	1725.08	2075.60
7	Total Input (Industry Standard)	136439.09	163993.76	177409.65	182659.45	163400.89	148129.48	152664.58	170484.06
8	Overall Input Output Ratio (Industry Standard)	1.0383	1.0006	0.9899	1.0008	0.9559	0.9784	1.0077	0.9612
9	Overall Productivity Ratio (Industry Standard)	0.9631	0.9994	1.0102	0.9992	1.0461	1.0221	0.9924	1.0404
10	Overall Productivity Indices (Industry Standard) (O)	100.00	103.77	104.89	103.75	108.62	106.13	103.04	108.02
11	Computed Value /Expected Values (E)	102.23	102.96	103.69	104.41	105.14	105.87	106.60	107.32
12	Chi-Square $(O-E)^2/E$	0.0487	0.0064	0.0140	0.0042	0.1152	0.0006	0.1186	0.0046

Average Overall Productivity Indices=104.78, a=104.78, b=0.36, χ^2=0.312, S.D.=2.62, C.V.=2.50%.

15: Overall Productivity of IOCL

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	326553.94	399196.39	382590.88	387987.09	362608.32	298354.22	287130.68	343394.88
2	Material Input	299785.74	362045.91	351690.29	346722.95	310163.65	240795.91	247461.57	273895.48
3	Labour Input	6435.55	4596.60	6086.05	5050.27	5094.13	5185.58	6336.74	6390.35
4	Overhead Input	18436.42	22663.97	23768.90	27586.42	26532.94	32126.51	34148.43	31044.81
5	Total Input (Company Standard)	324657.71	389306.47	381545.24	379359.63	341790.72	278108.00	287946.73	311330.64
6	Normal Investor Input @ 5.55% (Industry Standard)	4147.71	4337.25	5321.29	6132.80	6573.33	6735.49	6707.98	7381.33
7	Total Input (Industry Standard)	328805.42	393643.72	386866.53	385492.43	348364.05	284843.49	294654.71	318711.97
8	Overall Input Output Ratio (Industry Standard)	1.0069	0.9861	1.0112	0.9936	0.9607	0.9547	1.0262	0.9281
9	Overall Productivity Ratio (Industry Standard)	0.9932	1.0141	0.9889	1.0065	1.0409	1.0474	0.9745	1.0774
10	Overall Productivity Indices (Industry Standard) (O)	100.00	102.11	99.58	101.34	104.81	105.47	98.12	108.49
11	Computed Value /Expected Values (E)	99.96	100.68	101.41	102.13	102.85	103.57	104.29	105.01
12	Chi-Square $(O-E)^2/E$	0.0000	0.0202	0.0330	0.0061	0.0373	0.0347	0.3654	0.1150

Average Overall Productivity Indices=102.49, a=102.49, b=0.36, χ^2=0.612, S.D.=3.27, C.V.=3.19%.

16: Overall Productivity of RIL

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	247978.66	307735.63	313516.10	325963.44	273830.44	204990.51	202371.59	235728.97
2	Material Input	198076.21	256798.57	266657.65	272774.93	215874.20	135405.68	143569.06	168327.73
3	Labour Input	2624.17	2641.63	2807.30	2571.31	2642.86	2892.54	2890.97	3005.16
4	Overhead Input	26194.52	24594.48	25538.02	25550.00	27951.56	30384.11	30785.24	32376.11
5	Total Input (Company Standard)	226894.90	284034.68	295002.97	300896.24	246468.62	168682.32	177245.27	203709.00
6	Normal Investor Input @ 5.55% (Industry Standard)	12229.74	11569.65	11722.01	13364.56	15250.94	16973.86	20097.67	21536.07
7	Total Input (Industry Standard)	239124.64	295604.33	306724.98	314260.80	261719.56	185656.18	197342.94	225245.07
8	Overall Input Output Ratio (Industry Standard)	0.9643	0.9606	0.9783	0.9641	0.9558	0.9057	0.9752	0.9555
9	Overall Productivity Ratio (Industry Standard)	1.0370	1.0410	1.0221	1.0372	1.0463	1.1041	1.0255	1.0465
10	Overall Productivity Indices (Industry Standard) (O)	100.00	100.39	98.56	100.02	100.89	106.47	98.89	100.92
11	Computed Value /Expected Values (E)	99.79	100.07	100.35	100.63	100.91	101.19	101.47	101.75
12	Chi-Square $(O-E)^2/E$	0.0005	0.0010	0.0317	0.0037	0.0000	0.2760	0.0656	0.0068

Average Overall Productivity Indices=100.77, a=100.77, b=0.14, χ^2=0.385, S.D.=2.30, C.V.=2.28%.

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Annual Reports of Companies from 2010-11 to 2017-18

- BPCL
- HPCL
- IOCL
- RIL

Various Bulletins of Reserve Bank of India

- Wholesale Price Index, Consumer Price Index and Fuel and Power Index

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Contents

MEASURING PRODUCTIVITY IN IT SECTOR COMPANIES INCLUDED IN NIFTY 50: AN EMPIRICAL STUDY

-Dr. Meenu Maheshwari, Assistant Professor, Department of Commerce and Management, University of Kota, Kota, Rajasthan
-CA Priya Taparia, Research Scholar, Department of Commerce and Management, University of Kota, Kota, Rajasthan

ABSTRACT

Productivity is a ratio of monetary value of output to the monetary value of input. Higher the productivity ratio of a company denotes more efficiently the company has used its resources. In the present research, an attempt has been made to measure, analyse and compare productivity of four companies of IT sector during the period from 2010-11 to 2017-18 i.e. for eight years.

Intra-company comparison has been drawn with the help of chi-square test and results indicate that null hypothesis is accepted in all the cases of IT companies. Inter-company comparison has been drawn with the help of Kruskal Wallis One Way ANOVA Test and results indicate that null hypothesis is rejected.

After analysing the average overall productivity it is observed that overall productivity is almost one that means IT sector companies are not optimally utilizing its resources, it is just meeting its cost. It is recommended that the companies should take steps to maintain the productivity ratio high in future by optimally utilizing the resources.

Keywords: Overall Productivity, Investor Input, Average Investment, Kruskal Wallis One Way ANOVA Test.

INTRODUCTION

The idea of productivity has been continuously emerging since early fifties till contemporary times. The key to progress and prosperity lies in the essence of higher productivity leading to enhanced standard of living. The higher productivity has been marked by the curbed wastage, better wages and working conditions, low prices for consumers and higher dividends to shareholders, improved exports and foreign exchange etc. All these elements contribute towards social progress and economic growth, which in result; assist in eliminating the core problems of our country viz., mass poverty and mass unemployment. Hence, productivity serves as an important indication of the growth rate and performance of entire economy in this ever-changing scenario.

With the prevalence of technology over the time, things have become more feasible and easy that its adoption helps in saving time at great extent.

Hence, the concept of productivity has become a matter of great significance nowadays.

This modern era is full of many opportunities that may increase the productivity level. The productivity has now become the necessity, not only for the development of the organisation but also for the survival in this competitive world.

National Research Council (1979) stated, "Productivity is the relationship between output produced and one or more of associated inputs used in the production process."

Productivity of a concern indicates that how much has been produced as output by all the input taken together. It measures effective utilisation of overall input on the basis of limited output.

$$\text{Productivity} = \frac{\text{Total Output}}{\text{Total Input}}$$

LITERATURE REVIEW

Many studies on productivity trends in India and abroad have been carried out over the last few decades. Few studies are being summarised below:

Simpson (2009) in his research paper titled "Productivity in Public Services" explored the issues arising in measurement of productivity in public services. There are many limitations arising in measuring productivity of public services because mainly public services are unpriced and some public services are consumed collectively. These limitations are generally not faced in the private sector.

Jain (2011) in his thesis analysed the cost structure, profitability and productivity of five companies for a period of 5 years from 2004-05 to 2008-09 of pharmaceutical industry in India. The study also examined the scope for improvement in profitability by eradicating reasons responsible for low profit margin and suggested the ways and means by which management can improve the performance of the companies.

Globerson and Vitner (2019) has presented a model which aimed at measuring the productivity of a product or a service that are producing different products. Two methodologies have been adopted for calculating the output taking into consideration the value of item which are in process and assigning the weights to each and every product according to the level of usage of the most frequently used resource.

Research Gap: As per the above reviews and many more studies studied related to the topic, there is no study on overall productivity of IT sector companies included in Nifty 50. So in this present research an attempt has been made to measure the overall productivity of IT sector companies.

OBJECTIVES

1. To measure, analyse and compare the overall productivity for the IT sector companies included in Nifty 50.

2. To compare the intra-company and inter-company overall productivity for the study period.

3. To suggest ways for the improvement in overall productivity.

RESEARCH METHODOLOGY

Collection of Data

This research is based on the secondary data. The data and information regarding output, average investment, overall input and all other financial variables has been obtained from the

annual reports of the respective companies i.e. Infosys Ltd., Tata Consultancy Services Ltd., Tech Mahindra Ltd. and Wipro Ltd. The annual reports are available on the website of these companies and also the data related to index numbers has been collected from various bulletins published by Reserve Bank of India on its website.

Selection of Base Year

The year 2010-11 has been taken as the base year. The revaluation of output and input is done on the basis of this year.

Model to be used

In the present research Productivity Accounting Model propogated by H. S. Davis has been used for measuring overall productivity because it considers all the elements of output and input, ignoring the effect of inflation.

Hypotheses

Intra-Company Hypothesis: Tested with the help of Chi-Square Test.

Null Hypothesis (H0): There is no significant difference in the overall productivity indices of the sampled company for the study period and can be represented by straight line trend or line of best fit.

The acceptance of null hypothesis would reveal that the overall productivity indices of the sampled company for the study period are approximately equal.

Inter-Company Hypothesis: Tested with the help of Kruskal Wallis One Way ANOVA Test.

Null Hypothesis (H0): There is no significant difference in the overall productivity ratios for the sampled companies.

CALCULATION OF INDEX NUMBERS AND CONVERSION FACTORS

For revaluation of data as per the base year's prices index numbers and conversion factors has been used. Here base year is 2010-11. Backward Splicing technique has been used for calculating the index numbers of 2010-11. Following formula has been used to calculate conversion factors:

$$\frac{\text{Index number of the base year}}{\text{Index number for the current year}}$$

Table 1: Index Numbers and Conversion Factors for Revaluation of Data

Year	Wholesale Price Index		Consumer Price Index for Industrial Workers		Fuel and Power Index	
	Base year 2011-12 = 100	Conversion Factors	Base Year 2001 = 100	Conversion Factors	Base Year 2011-12 = 100	Conversion Factors
2010-11	91.80	1.000	180.00	1.000	87.75	1.000
2011-12	100.00	0.918	195.00	0.923	100.00	0.878
2012-13	106.90	0.859	215.00	0.837	107.10	0.819

2013-14	112.50	0.816	236.00	0.763	114.70	0.765
2014-15	113.90	0.806	251.00	0.717	107.70	0.815
2015-16	109.70	0.837	265.00	0.679	86.50	1.014
2016-17	111.60	0.823	276.00	0.652	86.30	1.017
2017-18	114.90	0.799	284.00	0.634	93.30	0.941

REVALUATION OF OUTPUT

The output of the companies has been revalued by multiplying the output values with the conversion based on wholesale price index.

REVALUATION OF OVERALL INPUT

All inputs that is material, labour, overhead and investor input are added together and constituted the overall input. When overall input is compared with the output, it is known as the overall productivity. Different inputs have been revalued with the different index numbers according to the nature of the inputs.

Material Input: Revalued with whole sale price index.
Labour Input: Revalued with consumer price index for industrial workers.
Overhead Input: Power and Fuel- Revalued with fuel and power index.
Repairs & Maintenance and Business Service Input: Revalued with wholesale price index. Depreciation and Amortisation- Not revalued.
Investor Input: Investor input is calculated by multiplying the base year rate of return with the average investment in succeeding years.
Average Investment: Fixed Assets: Taken on historical values as shown in the balance sheet. Non-current investments, long term loans and advances and other non-current assets, current assets, current liabilities, profit- Revalued with wholesale price index. Half of the profit has been deducted from the value of investment to obtain the average investment.
Base Year Rate of Return: The base year rate of return based on industry standard for inter-company comparison has been calculated with the help of the following formula:

$$R_I = \frac{R_1 + R_2 + R_3 + R_4 \text{ (Rate of Return of Sector Companies)}}{AI_1 + AI_2 + AI_3 + AI_4 \text{ (Average Investment of Sector Companies)}} \text{ X } 100 = 38.48\%$$

OVERALL PRODUCTIVITY

Overall productivity of IT sector companies has been shown from table 2 to 5 from 2010-11 to 2017-18 taking 2010-11 as the base year for revaluation.

Table 2: Overall Productivity of Infosys Ltd

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	26532.00	30814.51	33555.12	38284.27	40813.42	47702.30	51314.87	52702.04
2	Material Input	482.00	595.78	649.40	767.86	820.51	901.45	1041.92	1032.31
3	Labour Input	12459.00	14281.58	16683.08	18579.05	18007.46	19151.87	20175.49	20587.25
4	Overhead Input	4770.00	5443.02	5297.06	6414.54	6721.90	8626.95	9490.58	10124.12
5	Total Input (Company Standard)	17711.00	20320.38	22629.55	25761.44	25549.86	28680.28	30707.98	31743.68
6	Normal Investor Input @ 38.48% (Industry Standard)	8197.97	9036.04	10526.50	11843.11	13183.05	15971.19	19578.73	17454.79
7	Total Input (Industry Standard)	25908.97	29356.42	33156.05	37604.55	38732.91	44651.47	50286.71	49198.47
8	Overall Input Output Ratio (Industry Standard)	0.9765	0.9527	0.9881	0.9822	0.9490	0.9360	0.9800	0.9335
9	Overall Productivity Ratio (Industry Standard)	1.0240	1.0497	1.0120	1.0181	1.0537	1.0683	1.0204	1.0712
10	Overall Productivity Indices (Industry Standard) (O)	100.00	102.50	98.83	99.42	102.90	104.32	99.65	104.61

11	Computed Value / Expected Values (E)	99.95	100.40	100.85	101.30	101.75	102.21	102.66	103.11
12	Chi-Square (O-E)2/E	0.0000	0.0441	0.0406	0.0351	0.0129	0.0439	0.0882	0.0217

Average Overall Productivity Indices=101.53, a=101.53, b=0.23, x^2=0.2864, S.D.=2.17, C.V.=2.14%.

Overall productivity ratio is the lowest 1.0120 in 2012-13 while it is the highest 1.0712 in 2017-18. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overall input has not been utilized efficiently. The table value of chi-square at 5% level of significance with 8-1=7 d.f. is 14.067 while the calculated value of chi-square is 0.2864. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted. This reveals that the overall productivity indices of Infosys Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 3: Overall Productivity of Tata Consultancy Services Ltd

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	29771.01	38137.37	43513.96	55314.66	62904.22	74998.91	80044.98	82424.84
2	Material Input	17.75	10.84	21.51	32.47	52.13	33.34	1447.66	1602.00
3	Labour Input	10190.31	13014.68	14297.40	16378.99	19623.09	20416.30	31371.63	32650.37
4	Overhead Input	10840.77	12941.28	15402.10	18709.40	21642.28	25760.43	14520.79	14467.75
5	Total Input (Company Standard)	21048.83	25966.80	29721.01	35120.85	41317.50	46210.07	47340.08	48720.12
6	Normal Investor Input @ 38.48% (Industry Standard)	6197.68	7214.48	9278.16	11971.19	12266.20	16339.72	22020.57	20619.08
7	Total Input (Industry Standard)	27246.51	33181.28	38999.17	47092.04	53583.70	62549.79	69360.65	69339.20

8	Overall Input Output Ratio (Industry Standard)	0.9152	0.8700	0.8962	0.8513	0.8518	0.8340	0.8665	0.8412
9	Overall Productivity Ratio (Industry Standard)	1.0927	1.1494	1.1158	1.1746	1.1739	1.1990	1.1540	1.1887
10	Overall Productivity Indices (Industry Standard) (O)	100.00	105.19	102.12	107.50	107.44	109.74	105.62	108.79
11	Computed Value / Expected Values (E)	102.20	103.22	104.25	105.28	106.31	107.34	108.37	109.40
12	Chi-Square (O-E)2/E	0.0472	0.0374	0.0439	0.0467	0.0119	0.0533	0.0700	0.0034

Average Overall Productivity Indices=105.80, a=105.80, b=0.51, x^2=0.3138, S.D.=3.12, C.V.=2.94%.

Overall productivity ratio is the lowest 1.0927 in 2010-11 while it is the highest 1.1990 in 2015-16. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the overall input has not been utilized efficiently. For testing the hypothesis chi-square method has been used. The table value is 14.067 while the calculated value of chi-square is 0.3138. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted. This reveals that the overall productivity ratios of the company for the eight year period are same and can be represented by straight line trend or line of best fit.

Table 4: Overall Productivity of Tech Mahindra Ltd

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	5092.10	4875.22	5073.86	13354.17	15545.48	18479.45	19799.98	20288.13
2	Material Input	1.50	0.46	0.00	0.00	0.00	0.00	0.00	0.00

3	Labour Input	1943.80	2077.67	2104.05	5319.25	5163.26	5031.46	5049.35	5139.52
4	Overhead Input	2229.50	2130.54	2138.63	5122.90	7483.03	9060.59	10318.31	9985.39
5	Total Input (Company Standard)	4174.80	4208.67	4242.68	10442.15	12646.29	14092.05	15367.66	15124.92
6	Normal Investor Input @ 38.48% (Industry Standard)	1617.14	1585.10	1545.49	3030.11	3813.95	4592.07	5741.39	6347.51
7	Total Input (Industry Standard)	5791.94	5793.77	5788.17	13472.26	16460.24	18684.12	21109.05	21472.43
8	Overall Input Output Ratio (Industry Standard)	1.1374	1.1884	1.1408	1.0088	1.0588	1.0111	1.0661	1.0584
9	Overall Productivity Ratio (Industry Standard)	0.8792	0.8415	0.8766	0.9912	0.9444	0.9890	0.9380	0.9448
10	Overall Productivity Indices (Industry Standard) (O)	100.00	95.71	99.71	112.75	107.42	112.50	106.69	107.47
11	Computed Value / Expected Values (E)	99.44	101.11	102.78	104.45	106.12	107.78	109.45	111.12
12	Chi-Square (O-E)2/E	0.0032	0.2880	0.0917	0.6597	0.0161	0.2061	0.0698	0.1201

Average Overall Productivity Indices=105.28, a=105.28, b=0.83, x^2=1.4547, S.D.=5.81, C.V.=5.52 %.

The highest overall productivity ratio is in the year 2013-14 with 0.9912 and the lowest is in the year 2011-12 with 0.8415. Chi-square has been used for testing the hypothesis and its table value at 5% level of significance with 8-1=7 d.f. is 14.067 while the calculated value of chi-square of Tech Mahindra Ltd. is 1.4547. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted. This reveals that the overall productivity ratios of the company for the eight years period are approximately the same and can be represented by straight line trend or line of best fit.

Table 5: Overall Productivity of Wipro Ltd

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output	26949.60	30252.87	29664.36	32941.35	35024.33	39676.31	40209.89	37750.59
2	Material Input	3805.60	4300.74	2320.50	2079.58	2254.38	2221.82	1799.82	1174.21
3	Labour Input	10937.40	12286.51	13311.82	13991.51	14143.76	14516.82	14249.07	13793.43
4	Overhead Input	6428.30	7712.28	7311.19	7873.82	8632.23	10619.01	11158.75	10980.49
5	Total Input (Company Standard)	21171.30	24299.53	22943.51	23944.91	25030.37	27357.64	27207.64	25948.13
6	Normal Investor Input @ 38.48 % (Industry Standard)	8224.47	8815.26	7424.26	8818.90	10236.65	12689.51	14670.24	12666.31
7	Total Input (Industry Standard)	29395.77	33114.79	30367.77	32763.81	35267.02	40047.15	41877.88	38614.44
8	Overall Input Output Ratio (Industry Standard)	1.0908	1.0946	1.0237	0.9946	1.0069	1.0093	1.0415	1.0229
9	Overall Productivity Ratio (Industry Standard)	0.9168	0.9136	0.9768	1.0054	0.9931	0.9907	0.9602	0.9776

10	Overall Productivity Indices (Industry Standard) (O)	100.00	99.65	106.55	109.67	108.33	108.07	104.73	106.64
11	Computed Value / Expected Values (E)	102.33	103.22	104.11	105.01	105.90	106.79	107.69	108.58
12	Chi-Square (O-E)2/E	0.0529	0.1234	0.0571	0.2069	0.0556	0.0152	0.0811	0.0348

Average Overall Productivity Indices=105.45, a=105.45, b=0.45, x^2=0.6269, S.D.=3.52, C.V.=3.34%.

Overall productivity ratio is the highest 1.0054 in 2013-14 while it is the lowest 0.9136 in 2011-12. The highest overall productivity ratio is better as from more amount of output is obtained with small amount of input. The table value of chi-square at 5% level of significance with 8-1=7 d.f. is 14.067 while the calculated value of chi-square of Wipro Ltd. is 0.6269. As the calculated value of chi-square is less as compared to the table value hence null hypothesis is accepted. This reveals that the overall productivity indices for the Wipro Ltd. for the study period are approximately same and can be represented by straight line trend or line of best fit.

KRUSKAL WALLIS ONE WAY ANOVA TEST

The overall productivity of all the samples is combined and arranged in order of increasing size and given a rank number. The rank sum of each of the sample has been calculated. The detailed calculation has been done in the following table 6.

Table 6: Comparative Overall Productivity Ratios from 2010-11 to 2017-18 of IT Sector Companies and Kruskal Wallis One Way ANOVA Test

Base Year 2010-11

Year	**Infosys Ltd.**		**Tata Consultancy Services Ltd.**		**Tech Mahindra Ltd.**		**Wipro Ltd.**	
	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	1.0240	20	1.0927	25	0.8792	3	0.9168	5
2011-12	1.0497	21	1.1494	27	0.8415	1	0.9136	4
2012-13	1.0120	17	1.1158	26	0.8766	2	0.9768	10
2013-14	1.0181	18	1.1746	30	0.9912	14	1.0054	16
2014-15	1.0537	22	1.1739	29	0.9444	7	0.9931	15

2015-16	1.0683	23	1.1990	32	0.9890	12	0.9907	13
2016-17	1.0204	19	1.1540	28	0.9380	6	0.9602	9
2017-18	1.0712	24	1.1887	31	0.9448	8	0.9776	11
Total		164		228		53		83

H=26.8210

The calculated value of H is 26.8210 and the table value is 7.8147 at 5% level of significance with 4-1=3 degrees of freedom. As the calculated value is more than the table value hence null hypothesis is rejected. This means that the overall productivity ratios of the IT sector companies of Nifty 50 are not same that is there is a significant difference in overall productivity.

COMPARATIVE AVERAGE ANALYSIS

To analyse between the companies of a particular sector it is better to analyse its average performance of the study period. In the present study an attempt has been made to analyse and interpret the results on the basis of average performance.

Table 7: Comparative Average Overall Productivity of IT Sector Companies from 2010-11 to 2017-18

Base Year 2010-11

Companies	**Overall Input Output Ratio**		**Overall Productivity Ratio**		**Chi Square Test**	
	Average	Rank	Average	Rank	Value	Rank
Infosys Ltd.	0.9623	2	1.0397	2	0.286	1
Tata Consultancy Services Ltd.	0.8658	1	1.1560	1	0.314	2
Tech Mahindra Ltd.	1.0837	4	0.9256	4	1.455	4
Wipro Ltd.	1.0355	3	0.9668	3	0.627	3

The average overall input output ratio is the best of Tata Consultancy Services Ltd. by 0.8658, followed by Infosys Ltd. by 0.9623, Wipro Ltd. by 1.0355 and lastly 1.0837 of Tech Mahindra Ltd. Average overall productivity ratio is the best of Tata Consultancy Services Ltd. with 1.1560, then Infosys Ltd. with 1.0397, Wipro Ltd. with 1.0355 and lastly Tech Mahindra Ltd. with 0.9668. On analysing the chi-square of the IT sector companies it has been observed that Infosys Ltd. has the least chi-square value and Tech Mahindra Ltd. has the highest chi-square value. The table value of chi-square at 5% level of significance with 8-1=7 d.f. is 14.067. This shows that the null hypothesis based on the chi-square is accepted in all the above cases.

CONCLUSIONS

It may be concluded from the above analysis that the output per rupee of overall input is not satisfactory for all the companies of IT sector. The companies can take steps to reduce cost by optimally utilizing the material cost by improving the quality of raw material, improving technology of raw material processing and material handling transportation system. The labour cost can be optimally utilised by adopting techniques such as incentive schemes, workers participation in the management, job enrichment, flexitime, etc. Overhead productivity can be improved by reducing the expenses in overhead cost. Overhead cost such as electricity expenses can be reduced by avoiding the wastage of it. By reducing the cost it ultimately increases the productivity and hence the company becomes more productive.

SCOPE FOR FURTHER RESEARCH

This study is only based on the overall productivity of IT sector companies included in Nifty 50. More studies may be possible on other companies of other sectors of Nifty 50 and also on companies of BSE and Nifty 100. Productivity can also be calculated on the basis of individual factors such as material, labour, capital, etc.

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MEASUREMENT OF MATERIAL PRODUCTIVITY: A CASE STUDY OF AUTOMOBILE SECTOR COMPANIES INCLUDED IN NIFTY 50

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Abstract:

Productivity is essential in the long run life of an organisation. Monetary value of output is divided by the monetary value of input to obtain the productivity. The Material Productivity of Automobile sector companies included in Nifty Fifty has been analysed in the present study. The sector comprises of Bajaj Auto Ltd., Mahindra & Mahindra Ltd., Maruti Suzuki India Ltd. and Tata Motors Ltd. Material productivity of eight years has been studied in the present study. Both intra sector and inter sector hypotheses have been tested and results have been drawn from it. Kruskal Wallis One Way Analysis of Variance Test has been used for testing the hypothesis and it has been observed that null hypothesis is accepted and alternate hypothesis is rejected. This means that there is no significant difference in material productivity. For improving the material productivity it is recommended to improve the output, input or components related to output or input.

Keywords: Productivity Accounting, Material Productivity, Chi-Square Test, Kruskal Wallis One Way Analysis of Variance Test

Introduction:

Productivity is one of the most essential and important element in the financial success of an enterprise. In the present environment of economic development one of the main components for successful industrial organisation is planning for productivity. Now-a-days study of productivity growth is becoming more important because it allows company to behave competitive in the market and contribute positively towards the development of society. Productivity can be measured as a ratio between input and output. Increase in the productivity indicates reduction in the input cost or increase in the output. Simultaneously decrease in productivity can be possible if there is increase in input cost or reduction in output.

According to B. B. Lal, "Productivity as a measurable relationship between well-defined outputs and inputs, i.e., between the production results and the relative production agents in both the financial and physical terms in relation to given terms and conditions." According to C B Gupta, "Productivity refers to the physical

relationship between the quantity produced (Output) and quantity of resources used in the course of production (Input). It is the ratio between the output of goods and services and the inputs of resources consumed in the process of production". The term productivity and efficiency are synonyms. Yet there is a slight difference between the two. The productivity of an organisation may be indicated without any improvement in its efficiency. On the other hand, the efficiency of an input may increase without any simultaneous improvement in its productivity.

Review of Literature:

Many studies on productivity trends in India and abroad have been carried out over the last few decades. Few studies are being summarised below:

Bai and Li (2004) examined the convergence process of industrial productivity in Chinese region. Both standard deviation and beta convergence are explored using a panel of data over the period 1985-1999. Regional productivity showing the significant implication for government in policy making at both national and reginal levels. Although appreciable efforts have been made by researchers in testing income convergence across the Chinese region. The present study also analyse the output productivity performance of Chinese regions which are based on convergence concepts. Also human capital has been found to be an important factor in the elimination of productivity divergence between Chinese regions. It is suggested that the government has to play an active role in promoting these regions and to give incentives to international firms to invest in these regions.

Dogan, Wong and Yap (2013) in the paper explored the turnover, ownership and productivity in Malaysian manufacturing sector. The study decomposed the sources of productivity change in Malaysian manufacturing sector with an explicit role given to establishment turnover. The study also raised several issues of breakdown by selected industries. The author tried to analyse whether firm's turnover by ownership has any impact on the aggregate productivity growth of that particular sector. For this the usefulness of adopting such an analytical frame work is necessary so study for a period from 2000 to 2005 has been carried out The foreign entrants were relatively more productive than small one because they also get benefits from small economies.

Shahbazi, Salloun, Kurdve and Wiktorsson (2017) in their paper presented the recent current practice of material efficiency performance indicators in the manufacturing sector area through a bottom up approach. The data was collected with the help of a case study at seven global manufacturing companies located in Sweden through semi structured interviews of environmental coordinators, plant directors and production managers as they have a deep knowledge about the reporting requirement on environment, companies manufacturing and environmental strategies and overall companies goals. On analyzing the data it is concluded that existing material efficiency indicators in Sweden are limited and mainly measuring as a cost or quality parameter, environment factor has been ignored.

Main Objective of the Research Work:

The main objectives are being summarized as follows:-

1) To measure, analyse and compare the material productivity ratios of the automobile sector companies included in Nifty 50.
2) To measure, analyse and compare the intra company material productivity ratios for the study period.
3) To measure, analyse and compare the inter company material productivity ratios for the study period.
4) To suggest ways for the improvement in material productivity ratios.

Research Methodology:

Collection of Data:

This research is based on the secondary data. The data and information regarding output, sales, material consumed, total inputs and all other financial variables have been obtained from the annual reports of the respective companies. To remove the inflation effect of prices on outputs and inputs, the revaluation of the values of outputs and inputs have been made. For the revaluation of values, index numbers have been used.

Selection of Base Year:

Automobile sector companies of Nifty 50 have been selected. The study covers a period of eight years i.e. from 2010-11 to 2017-18. The year 2010-11 has been taken as a base year.

Model to be used:

In the present research work Productivity Accounting Model propogated by H. S. Davis has been used for measuring productivity because it considers all the elements of output and input, ignoring the effect of inflation

Hypotheses:

Keeping in mind the objectives of the research work, following hypotheses have been developed which will be tested.

Intra Company Comparison

To measure, analyse and compare the material productivity ratios of the sampled company for the study period following hypothesis has been developed which will be tested and analysed with the help of the Chi-Square Test.

Null Hypothesis (H_0): There is no significant difference in the material productivity indices of the sampled company for the study period and can be represented by straight line trend or line of best fit.

Alternate Hypothesis (H_1): There is a significant difference in the material productivity indices of the sampled company for the study period and cannot be represented by straight line trend or line of best fit.

Inter Company Comparison

To measure, analyse and compare the material productivity ratios of sampled companies following hypothesis has been developed which will be tested with the help of Kruskal Wallis One Way Analysis of Variance Test.

Null Hypothesis (H_0): There is no significant difference in the material productivity ratios of sampled companies.

Alternate Hypothesis (H_1): There is a significant difference in the material productivity ratios of sampled companies.

Calculation of Index Numbers and Conversion Factors:

Wholesale price index has been used for revaluating the output and the material input. Following formula has been used to calculate conversion factors:

Index number of the base year
Index number for the current year

Table 1

Index Numbers and Conversion Factors for Revaluation of Data

Year	Wholesale Price Index Base year 2011-12 = 100	Conversion Factors
2010-11	91.80	1.000
2011-12	100.00	0.918
2012-13	106.90	0.859
2013-14	112.50	0.816
2014-15	113.90	0.806
2015-16	109.70	0.837
2016-17	111.60	0.823
2017-18	114.90	0.799

Revaluation of Output:

The output of the companies has been revalued by multiplying the output values with the conversion factors. Here for the purpose of the study revenue from operations, other income and change in the inventories of finished goods, work in progress and stock in trade are considered as output. Revaluation of Output of the companies from 2010-11 to 2017-18 has been calculated and shown in Appendix 1 to 4 respectively.

Revaluation of Material Input:

The material input of the companies has been revalued by multiplying the input values with the conversion factors. Here for the purpose of this study, the material input includes raw material and components, stores and spares and purchases of traded goods or stock in trade. Revaluation of input of the companies from 2010-11 to 2017-18 has been calculated and shown in Appendix 5 to 8 respectively.

Material Productivity of Automobile Sector:

Materials are regarded as essential and important in the cost of production because of the dependence of manufacturing activities on material input. If an organisation uses material input optimally then there are more chances of survival in the long run. Material Productivity indicates that how much has been produced as output by a unit of material input. Material Productivity of automobile sector companies has been shown from Table 2 to 5.

Table 2

Material Productivity of Bajaj Auto Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (Rs in Crore)	16891.95	18399.35	17881.58	17003.01	17842.32	19807.03	18883.71	21190.96
2	Raw Material and Components (Rs in Crore)	11521.98	12593.89	11836.29	10775.38	11336.87	11740.09	11135.36	12998.40
3	Raw Material and Components (Input Output Ratio)	0.6821	0.6845	0.6619	0.6337	0.6354	0.5927	0.5897	0.6134
4	Stores and Spares (Rs in Crore)	85.00	101.21	106.39	101.98	106.14	110.32	94.34	94.05
5	Stores and Spares (Input Output Ratio)	0.0050	0.0055	0.0059	0.0060	0.0059	0.0056	0.0050	0.0044
6	Purchases of Traded Goods/Stock in Trade (Rs in Crore)	568.41	689.56	737.73	782.63	930.58	1068.35	1137.77	1119.60
7	Purchases of Traded Goods/ Stock in Trade (Input Output Ratio)	0.0336	0.0375	0.0413	0.0460	0.0522	0.0539	0.0603	0.0528
8	Total Material Input (Rs in Crore)	12,175.39	13,384.66	12,680.41	11,659.99	12,373.59	12,918.76	12,367.47	14,212.05
9	Material (Input Output Ratio)	0.7208	0.7275	0.7091	0.6858	0.6935	0.6522	0.6549	0.6707
10	Material Productivity Ratio	1.3874	1.3747	1.4102	1.4582	1.4420	1.5332	1.5269	1.4911
11	Material Productivity Indices/ Observed Indices (O)	100.00	99.08	101.64	105.11	103.93	110.51	110.05	107.47
12	Computed Value of Y/Expected Values (E)	99.20	100.78	102.36	103.94	105.51	107.09	108.67	110.25
13	Chi-Square $(O-E)^2/E$	0.0064	0.0286	0.0050	0.0132	0.0237	0.1090	0.0176	0.0700

Average Material Productivity Indices = 104.73, Value of a = 104.73, b= 0.789, Chi Square = 0.2735, Standard Deviation = 4.09, Coefficient of Variation = 3.91%.

Analysis and Interpretation:

The revalued output of Bajaj Auto Ltd. is showing an erratic trend which is the highest Rs 21190.96 crore in 2017-18 and the lowest Rs 16891.95 crore in 2010-11. Total material inputs consist of raw material and components, stores and spares, purchases of traded goods/ stock in trade. Raw material and components input output ratio is the highest 0.6845 in 2011-12 while it is the lowest 0.5897 in 2016-17. Another very important part of total material input is stores and spares. Input output ratio of stores and spares is the lowest 0.0044 in 2017-18 as compared to the highest 0.0060 in 2013-14. Purchases of traded goods input output ratio is the lowest 0.0336 in 2010-11 indicates optimum utilisation. Total material input is Rs 12,175.39 crore in 2010-11 and it reached to Rs 14,212.05 crore in 2017-18. Total material input output ratio the highest 0.7275 in 2011-12 while it is the lowest 0.6522 in 2015-16. The lowest material input output ratio means material has been best utilized in the year 2015-16.

Material productivity ratio is the lowest 1.3747 in 2011-12 while it is the highest 1.5332 in 2015-16 showing an erratic trend. Improvement in material efficiency can also be observed from the average of material indices which worked out as 104.73 as compared to the base year index of 100. The standard deviation calculated is 4.09 and coefficient of variation is 3.91 % which shows that there is less variation in the data. The computed value of chi square is 0.2735. The table value of chi square at 5% level of significance with (8-1) = 7 degree of

freedom is 14.07. As the calculated value of chi square is less as compared to the table value hence null hypothesis is accepted and alternate hypothesis is rejected. This reveals that the material productivity indices of the company for the study period are approximately equal and can be represented by straight line trend or line of best fit.

Table 3

Material Productivity of Mahindra & Mahindra Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (Rs in Crore)	23692.18	29120.78	35143.67	33416.69	31931.62	34755.61	37410.97	39883.51
2	Raw Material and Components (Rs in Crore)	14708.94	17262.55	17824.14	17650.15	16339.62	16215.33	17389.70	18588.98
3	Raw Material and Components (Input Output Ratio)	0.6208	0.5928	0.5072	0.5282	0.5117	0.4666	0.4648	0.4661
4	Stores and Spares (Rs in Crore)	138.71	148.57	148.37	148.87	144.91	128.10	132.74	143.81
5	Stores and Spares (Input Output Ratio)	0.0059	0.0051	0.0042	0.0045	0.0045	0.0037	0.0035	0.0036
6	Purchases of Stock in Trade (Rs in Crore)	1757.23	4858.59	8377.55	6590.77	5931.65	8712.55	8965.46	8528.90
7	Purchases of Stock in Trade (Input Output Ratio)	0.0742	0.1668	0.2384	0.1972	0.1858	0.2507	0.2396	0.2138
8	Total Material Input (Rs in Crore)	16,604.88	22,269.71	26,350.06	24,389.79	22,416.18	25,055.98	26,487.90	27,261.69
9	Material (Input Output Ratio)	0.7009	0.7647	0.7498	0.7299	0.7020	0.7209	0.7080	0.6835
10	Material Productivity Ratio	1.4268	1.3076	1.3337	1.3701	1.4245	1.3871	1.4124	1.4630
11	Material Productivity Indices/ Observed Indices (O)	100.00	91.65	93.48	96.03	99.84	97.22	98.99	102.53
12	Computed Value of Y/Expected Values (E)	94.57	95.40	96.22	97.05	97.88	98.71	99.53	100.36
13	Chi-Square $(O-E)^2/E$	0.3117	0.1474	0.0786	0.0109	0.0391	0.0225	0.0030	0.0471

Average Material Productivity Indices = 97.47, Value of a = 97.47, b= 0.414, Chi Square = 0.6603, Standard Deviation = 3.39, Coefficient of Variation = 3.48%.

Analysis and Interpretation:

The revalued output of Mahindra & Mahindra Ltd. is Rs 23692.18 crore in 2010-11 and reached to Rs 39883.51 crore in 2017-18. Raw material and Components input output ratio is the highest 0.6208 in 2010-11 while it is the lowest 0.4648 in 2016-17. Input output ratio of stores and spares is the lowest 0.0035 in 2016-17 as compared to the highest 0.0059 in 2010-11. Purchases of Stock in Trade input output ratio is the lowest 0.0742 in 2010-11 indicates less stock in trade has been purchased for the purpose of business. Total material input consumption is showing an erratic trend. Total material input output ratio is the highest 0.7647 in 2011-12 while it is the lowest 0.6835 in 2017-18. The lowest material input output ratio means total material has been best utilized in the year 2017-18 as compared to other years under study.

Material productivity ratio of Mahindra & Mahindra Ltd. is the lowest 1.3076 in 2011-12 while it is the highest 1.4630 in 2017-18. Standard deviation is 3.39 while its coefficient of variation is 3.48 %. The computed value of chi square of Mahindra & Mahindra Ltd. is 0.6603. The table value is 14.07. As the calculated value of chi square is less as compared to the table value hence null hypothesis is accepted indicating that the material productivity indices of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 4

Material Productivity of Maruti Suzuki India Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (Rs in Crore)	37071.20	33307.52	38159.96	36346.27	40579.12	48726.04	57572.80	65397.27
2	Raw Material and Components (Rs in Crore)	27141.80	24517.03	26069.96	23581.50	26491.45	29886.68	35084.16	35908.10
3	Raw Material and Components (Input Output Ratio)	0.7322	0.7361	0.6832	0.6488	0.6528	0.6134	0.6094	0.5491
4	Stores and Spares (Rs in Crore)	70.20	83.63	160.12	134.40	145.16	179.12	184.43	188.72
5	Stores and Spares (Input Output Ratio)	0.0019	0.0025	0.0042	0.0037	0.0036	0.0037	0.0032	0.0029
6	Purchases of Stock in Trade (Rs in Crore)	1278.10	1406.84	1878.12	1984.02	2148.15	2616.80	3688.77	7984.41
7	Purchases of Stock in Trade (Input Output Ratio)	0.0345	0.0422	0.0492	0.0546	0.0529	0.0537	0.0641	0.1221
8	Total Material Input (Rs in Crore)	28,490.10	26,007.50	28,108.20	25,699.92	28,784.76	32,682.60	38,957.36	44,081.23
9	Material (Input Output Ratio)	0.7685	0.7808	0.7366	0.7071	0.7093	0.6707	0.6767	0.6741
10	Material Productivity Ratio	1.3012	1.2807	1.3576	1.4143	1.4097	1.4909	1.4778	1.4836
11	Material Productivity Indices/ Observed Indices (O)	100.00	98.42	104.34	108.69	108.34	114.58	113.58	114.02
12	Computed Value of Y/Expected Values (E)	99.23	101.67	104.10	106.53	108.96	111.39	113.82	116.26
13	Chi-Square $(O-E)^2/E$	0.0059	0.1034	0.0005	0.0438	0.0035	0.0911	0.0005	0.0432

Average Material Productivity Indices = 107.74, Value of a = 107.74, b= 1.216, Chi Square = 0.2920, Standard Deviation=5.91, Coefficient of Variation = 5.49 %.

Analysis and Interpretation:

The output of Maruti Suzuki India Ltd. is showing an erratic trend. It is the highest Rs 65397.27 crore in 2017-18 and it is the lowest Rs 33307.52 crore in 2011-12. Raw material and Components is the highest Rs 35908.10 crore in 2017-18 while it is the lowest Rs 23581.50 in 2013-14. Raw material and components input output ratio is the highest 0.7361 in 2011-12 while it is the lowest 0.5491 in 2017-18. The lowest raw material and components input output ratio indicates optimum raw material and components utilisation has been achieved in this year. Input output ratio of stores and spares is the lowest 0.0019 in 2010-11 as compared to the highest 0.0042 in 2012-13. Stock in trade is purchased is showing an increasing trend. Total material input output ratio is the highest 0.7808 in 2011-12 while it is the lowest 0.6707 in 2015-16. The lowest material input output ratio means material has been best utilized in the year 2015-16.

Material productivity ratio of Maruti Suzuki India Ltd. is the lowest 1.2807 in 2011-12 while it is the highest 1.4909 in 2015-16. Improvement in material efficiency can also be observed from the average of material indices which is 107.74 as compared to the base year index of 100. The standard deviation of Maruti Suzuki India Ltd. is 5.91 with 5.49 % of variability. The computed value of chi square is 0.2920. The table value is 14.07. As the calculated value of chi square is less as compared to the table value hence null hypothesis is accepted and alternate hypothesis is rejected. This reveals that the material productivity indices of the company for the study period are approximately same and can be represented by straight line trend or line of best fit.

Table 5

Material Productivity of Tata Motors Ltd. from 2010-11 to 2017-18

Base Year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
1	Output (Rs in Crore)	47157.19	49807.74	40124.16	31410.17	30067.20	37267.99	37072.17	48923.62
2	Raw Material and Components (Rs in Crore)	27058.47	31115.44	23402.84	16722.18	17857.12	20350.05	22757.31	29627.28
3	Raw Material and Components (Input Output Ratio)	0.5738	0.6247	0.5833	0.5324	0.5939	0.5460	0.6139	0.6056
4	Stores and Spares (Rs in Crore)	625.45	691.27	563.22	406.29	360.57	394.18	537.92	510.84
5	Stores and Spares (Input Output Ratio)	0.0133	0.0139	0.0140	0.0129	0.0120	0.0106	0.0145	0.0104
6	Purchases of Products for Sale (Rs in Crore)	7363.13	5906.37	5037.56	4120.65	4646.78	4402.01	3247.53	3805.17
7	Purchases of Products for Sale (Input Output Ratio)	0.1561	0.1186	0.1255	0.1312	0.1545	0.1181	0.0876	0.0778
8	Total Material Input (Rs in Crore)	35,047.05	37,713.08	29,003.62	21,249.12	22,864.47	25,146.23	26,542.76	33,943.29
9	Material (Input Output Ratio)	0.7432	0.7572	0.7228	0.6765	0.7604	0.6747	0.7160	0.6938
10	Material Productivity Ratio	1.3455	1.3207	1.3834	1.4782	1.3150	1.4821	1.3967	1.4413
11	Material Productivity Indices/ Observed Indices (O)	100.00	98.15	102.82	109.86	97.73	110.15	103.80	107.12
12	Computed Value of Y/Expected Values (E)	100.04	101.09	102.13	103.18	104.23	105.27	106.32	107.37
13	Chi-Square $(O-E)^2/E$	0.0000	0.0850	0.0046	0.4323	0.4047	0.2255	0.0597	0.0006

Average Material Productivity Indices = 103.70, Value of a = 103.70, b= 0.523, Chi Square = 1.2123, Standard Deviation= 4.64, Coefficient of Variation = 4.47%.

Analysis and Interpretation:

The revalued output of Tata Motors Ltd. is the highest Rs 49807.74 crore in 2011-12 while it is the lowest in Rs 30067.20 crore in 2014-15. Raw material and Components is the highest Rs 31115.44 crore in 2011-12 and the lowest Rs 16722.18 crore in 2013-14. Its components input output ratio is the highest 0.6247 in 2011-12 while it is the lowest 0.5324 in 2013-14. Stores and spares consumption is the highest Rs 691.27 crore in 2011-12 while it is the lowest Rs 360.57 crore in 2014-15. Input output ratio of stores and spares is the lowest 0.0104 in 2017-18 as compared to the highest 0.0145 in 2016-17. Purchases of Products for Sale is the lowest Rs 3247.53 crore in 2016-17 as compared to Rs 7363.13 crore in 2010-11. Input output ratio is the lowest 0.0778 in 2017-18 indicates less products for sale purchased for the purpose of business. It is the highest 0.1561 in 2010-11. Total material input output ratio is the highest 0.7572 in 2011-12 while it is the lowest 0.6747 in 2015-16.

Material productivity ratio is the lowest 1.3150 in 2014-15 while it is the highest 1.4821 in 2015-16. The highest ratio indicates efficiency and effectiveness while the lowest ratio indicates that the material input has not been utilized efficiently. The computed value of chi square of Tata Motors Ltd. is 1.2123. The table value of is 14.07. As the calculated value of chi square is less as compared to the table value hence null hypothesis is accepted and alternate hypothesis is rejected.

Material Productivity Ratios of Automobile Sector and Kruskal Wallis One Way Analysis of Variance Test:

Below table shows the material productivity ratios of the companies of the Automobile sector. The material productivity of all the samples is combined and arranged in order of increasing size and given a rank number. The detailed calculation has been done in the following table.

Table 6

Comparative Material Productivity Ratios from 2010-11 to 2017-18 of Automobile Sector and Kruskal Wallis One Way Analysis of Variance Test

Base Year 2010-11

	Bajaj Auto Ltd.		Mahindra & Mahindra Ltd.		Maruti Suzuki India Ltd.		Tata Motors Ltd.	
Year	Ratio	Rank 1	Ratio	Rank 2	Ratio	Rank 3	Ratio	Rank 4
2010-11	1.3874	13	1.4268	20	1.3012	2	1.3455	7
2011-12	1.3747	10	1.3076	3	1.2807	1	1.3207	5
2012-13	1.4102	16	1.3337	6	1.3576	8	1.3834	11
2013-14	1.4582	23	1.3701	9	1.4143	18	1.4782	26
2014-15	1.4420	22	1.4245	19	1.4097	15	1.3150	4
2015-16	1.5332	32	1.3871	12	1.4909	29	1.4821	27
2016-17	1.5269	31	1.4124	17	1.4778	25	1.3967	14
2017-18	1.4911	30	1.4630	24	1.4836	28	1.4413	21
Total		177		110		126		115

H = 4.0256

H Test follows the Chi-Square distribution with (k-1) degree of freedom. k is the number of samples. Here in this case degree of freedom is 4-1 = 3. At 5 % level of significance with 3 degrees of freedom, the critical value/ table value is 7.8147. The calculated value of H is 4.0256 and the table value is 7.8147. As the calculated value is less than the table value hence null hypothesis accepted and alternate hypothesis is rejected. This means that the material productivity ratios of the automobile sector companies of Nifty 50 are approximately same that is there is no significant difference in material productivity.

Possible Savings in Material Input:

Possible savings in material input has been calculated to analyse what would have been saved if optimum utilisation of raw material is made. To know the performance of the companies in respect of the material an attempt has been made to calculate the possible savings.

Table 7

Possible Savings in Material Input of Automobile Sector from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bajaj Auto Ltd.	Mahindra & Mahindra Ltd.	Maruti Suzuki India Ltd.	Tata Motors Ltd.
2010-11	Standard	11017	1757	1278	31817
	Actual	12175	16605	28490	35047
	Saving	**1158**	**14848**	**27212**	**3230**
2011-12	Standard	12000	19904	22339	33605
	Actual	13385	22270	26008	37713
	Saving	**1385**	**2366**	**3669**	**4108**
2012-13	Standard	11662	24021	25594	27072
	Actual	12680	26350	28108	29004
	Saving	**1018**	**2329**	**2514**	**1932**
2013-14	Standard	11089	22840	24377	21192
	Actual	11660	24390	25700	21249
	Saving	**571**	**1550**	**1323**	**57**
2014-15	Standard	11637	21825	27216	20286
	Actual	12374	22416	28785	22864
	Saving	**737**	**591**	**1569**	**2578**
2015-16	Standard	12918	23755	32682	25146
	Actual	12918	25056	32682	25146
	Saving	**0**	**1301**	**0**	**0**
2016-17	Standard	12316	25570	38614	25013
	Actual	12367	26488	38957	26543
	Saving	**51**	**918**	**343**	**1530**
2017-18	Standard	13821	27261	43862	3805
	Actual	14212	27261	44081	33943
	Saving	**391**	**0**	**219**	**30138**
Total Savings		5311	23902	36848	43573

Note: Amount has been rounded off to nearest ₹

Table 7 suggests that the total savings in material input for a period of eight years would have been Rs 5311 crore of Bajaj Auto Ltd., Rs 23902 crore of Mahindra & Mahindra Ltd., Rs 36848 crore of Maruti Suzuki India Ltd. and lastly Rs 43573 crore of Tata Motors Ltd. For calculating possible savings year of the lowest material input output ratio has been taken as the base year. The year 2015-16 has been regarded as the base year for Bajaj Auto Ltd., Maruti Suzuki India Ltd and Tata Motors Ltd. For Mahindra and Mahindra Ltd. base year is 2017-18.

Total material inputs consist of raw material and components, stores and spares and purchases of traded goods or stock in trade.

1. **Possible Savings in Raw material and Components Input:**

   The most important aspect of material input is raw material and components.

Table 8

Possible Savings in Raw Material and Components Input of Automobile Sector from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bajaj Auto Ltd.	Mahindra & Mahindra Ltd.	Maruti Suzuki India Ltd.	Tata Motors Ltd.
2010-11	Standard	9961	11012	20356	25106
	Actual	11522	14709	27142	27058
	Saving	**1561**	**3697**	**6786**	**1952**
2011-12	Standard	10850	13535	18289	26518
	Actual	12594	17263	24517	31115
	Saving	**1744**	**3728**	**6228**	**4598**
2012-13	Standard	10545	16335	20954	21362
	Actual	11836	17824	26070	23403
	Saving	**1292**	**1489**	**5116**	**2041**
2013-14	Standard	10027	15532	19958	16722
	Actual	10775	17650	23582	16722
	Saving	**749**	**2118**	**3624**	**0**
2014-15	Standard	10522	14842	22282	16008
	Actual	11337	16340	26491	17857
	Saving	**815**	**1498**	**4209**	**1849**
2015-16	Standard	11680	16154	26755	19841
	Actual	11740	16215	29887	20350
	Saving	**60**	**61**	**3131**	**509**
2016-17	Standard	11135	17390	31613	19737
	Actual	11135	17390	35084	22757
	Saving	**0**	**0**	**3471**	**3020**
2017-18	Standard	12496	18538	35908	26047
	Actual	12998	18589	35908	29627
	Saving	**502**	**51**	**0**	**3580**
Total Savings		6722	12642	32566	17549

Note: Amount has been rounded off to nearest ₹

Table 8 shows that the total savings in raw material and components input for a period of eight years is Rs 6722 crore of Bajaj Auto Ltd., Rs 12642 crore of Mahindra & Mahindra Ltd., Rs 32566 crore of Maruti Suzuki India Ltd. and lastly Rs 17549 crore of Tata Motors Ltd. For calculating possible savings year of the lowest raw material and components input output ratio has been taken as the base year. The year 2016-17 has been regarded as the base year for Bajaj Auto Ltd. For Mahindra and Mahindra Ltd. base year is 2016-17, for Maruti Suzuki Ltd. base year is 2017-18, for Tata Motors Ltd. base year is 2013-14.

2. Possible savings in Stores and Spares input of automobile sector from 2010-11 to 2017-18:

Another important aspect to discuss and analyse is stores and spares.

Table 9

Possible savings in Stores and Spares Input of Automobile Sector from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bajaj Auto Ltd.	Mahindra & Mahindra Ltd.	Maruti Suzuki India Ltd.	Tata Motors Ltd.
2010-11	Standard	74	83	70	490
	Actual	85	139	70	625
	Saving	**11**	**56**	**0**	**135**
2011-12	Standard	81	102	63	518
	Actual	101	149	84	691
	Saving	**20**	**47**	**21**	**173**
2012-13	Standard	79	123	73	417
	Actual	106	148	160	563
	Saving	**27**	**25**	**87**	**146**
2013-14	Standard	75	117	69	327
	Actual	102	149	134	406
	Saving	**27**	**32**	**65**	**79**
2014-15	Standard	79	112	77	313
	Actual	106	145	145	361
	Saving	**27**	**33**	**68**	**48**
2015-16	Standard	87	122	93	388
	Actual	110	128	179	394
	Saving	**23**	**6**	**86**	**6**
2016-17	Standard	83	133	109	386
	Actual	94	133	184	538
	Saving	**11**	**0**	**75**	**152**
2017-18	Standard	94	140	124	511
	Actual	94	143	189	511
	Saving	**0**	**3**	**65**	**0**
Total Savings		146	203	466	740

Note: Amount has been rounded off to nearest ₹

Table 9 reveals that total savings in Stores and Spares input for a period of eight years is of Bajaj Auto Ltd. is Rs 146 crore which annually amounts to Rs. 18.25 crore approximately. It is Rs 203 crore of Mahindra & Mahindra Ltd. which annually amounts to Rs 25.38 crore approximately. Annual savings in stores and spares of Maruti Suzuki India Ltd. is 58.25 crore and calculating total savings for the study period amounts to Rs 466 crore. Lastly Rs 740 crore of savings may be possible of Tata Motors Ltd which annually amounts to Rs 92.50 crore.

3. **Possible savings in Purchases of Traded Goods or Stock in Trade input of automobile sector from 2010-11 to 2017-18:**

Another aspect of material input is purchases of traded goods or stock in trade.

Table 10

Possible savings in Purchases of Traded Goods or Stock in Trade Input of Automobile Sector from 2010-11 to 2017-18

Amount in ₹ crore

Companies		Bajaj Auto Ltd.	Mahindra & Mahindra Ltd.	Maruti Suzuki India Ltd.	Tata Motors Ltd.
2010-11	Standard	568	1757	1278	3669
	Actual	568	1757	1278	7363
	Saving	**0**	**0**	**0**	**3694**
2011-12	Standard	618	2161	1149	3875
	Actual	690	4859	1407	5906
	Saving	**72**	**2698**	**258**	**2031**
2012-13	Standard	601	2608	1317	3122
	Actual	738	8378	1878	5038
	Saving	**137**	**5770**	**561**	**1916**
2013-14	Standard	571	2480	1254	2444
	Actual	783	6591	1984	4121
	Saving	**212**	**4111**	**730**	**1677**
2014-15	Standard	600	2369	1400	2339
	Actual	931	5932	2148	4647
	Saving	**331**	**3563**	**748**	**2308**
2015-16	Standard	666	2579	1681	2899
	Actual	1068	8713	2617	4402
	Saving	**402**	**6134**	**936**	**1503**
2016-17	Standard	634	2776	1986	2884
	Actual	1138	8965	3689	3248
	Saving	**504**	**6189**	**1703**	**364**
2017-18	Standard	712	2959	2256	3805
	Actual	1120	8529	7984	3805
	Saving	**408**	**5570**	**5728**	**0**
Total Savings		2067	34036	10664	13493

Note: Amount has been rounded off to nearest ₹

Table 10 suggests that Rs 34036 crore would be possible saving of Mahindra & Mahindra Ltd. if its input is optimally utilized. Tata Motors Ltd. would also have saved Rs 13493 crore, Maruti Suzuki India Ltd. would have saved Rs 10664 crore and lastly Bajaj Auto Ltd. would have saved Rs 2067 crore.

Comparative Average Analysis:

To analyse between the companies of a particular sector it is better to analyse its average performance of the study period. In the present study an attempt has been made to analyse and interpret the results on the basis of average performance.

Table 11

Comparative Average Material Productivity of Automobile Sector Companies Included in Nifty 50 from 2010-11 to 2017-18

Base Year 2010-11

Companies	Raw Material and Components (Input Output Ratio)		Stores and Spares (Input Output Ratio)		Purchase of Traded Goods/Stock in Trade (Input Output Ratio)		Total Material (Input Output Ratio)		Material Productivity Ratio		Chi Square Test	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Value	Rank
Bajaj Auto Ltd.	0.6367	4	0.0054	3	0.0472	1	0.6893	1	1.4529	1	0.2735	1
Mahindra & Mahindra Ltd.	0.5198	1	0.0044	2	0.1958	4	0.7200	4	1.3907	4	0.6603	3
Maruti Suzuki India Ltd.	0.6531	3	0.0032	1	0.0592	2	0.7155	2	1.4020	2	0.2920	2
Tata Motors Ltd.	0.5842	2	0.0127	4	0.1212	3	0.7181	3	1.3954	3	1.2123	4

The raw material and components average input output ratio is the best of Mahindra & Mahindra Ltd. by 0.5198, followed by Tata Motors Ltd. by 0.5842, Maruti Suzuki India Ltd. by 0.6531 and lastly Bajaj Auto Ltd. by 0.6367. Stores and spares average input output ratio is the best of Maruti Suzuki India Ltd. as compared to Bajaj Auto Ltd., Mahindra & Mahindra Ltd. and Tata Motors Ltd. Purchase of traded goods/stock in trade average input output ratio is 0.0472 of Bajaj Auto Ltd., 0.0592 of Maruti Suzuki India Ltd., 0.1212 of Tata Motors Ltd. and 0.1958 of Mahindra & Mahindra Ltd. The total material average input output ratio is the best of Bajaj Auto Ltd. with 0.6893, followed by Maruti Suzuki India Ltd. with 0.7155, Tata Motors Ltd. 0.7181, Mahindra & Mahindra Ltd. 0.7200. Average material productivity ratio is the best of Bajaj Auto Ltd. with 1.4529 which means that for every one unit of material input, the output produced is 1.4529. This is followed by Maruti Suzuki India Ltd. with 1.4020 then Tata Motors Ltd. with 1.3954 and lastly Mahindra & Mahindra Ltd. with 1.3907. On analysing the Chi Square of the Automobile Sector Companies included in Nifty 50 it has been observed that Bajaj Auto Ltd. has the least chi square value with 0.2735 then the Maruti Suzuki India Ltd. with 0.2920, followed by Mahindra & Mahindra Ltd. with 0.6603 and lastly it is Tata Motors Ltd. with the highest chi square value 1.2123. The table value is 14.07. This shows that the null hypothesis based on the chi square is accepted in all the above cases. This means that the alternate hypothesis is rejected. This reveals that the material productivity ratios of all the companies of automobile sector of nifty 50 for the eight years period are approximately the same.

Conclusion:

It may be concluded from the above analysis that the output per rupee of material input is neither too good nor too bad of automobile sector companies included in Nifty 50. Output obtained from one unit of input is satisfactory but not optimum. Steps should be taken to stop the wastage of material and optimally use material input so that its productivity ratio improves. However, on analyzing automobile sector as a whole, it may be observed that the material productivity was the best of Bajaj Auto Ltd. as it has the highest output per rupee of material input. Its average material productivity ratio is 1.4529 which is the highest among the others. Next highest average material productivity ratio is 1.4020 of Maruti Suzuki India Ltd., followed by 1.3954 of Tata motors Ltd. and lastly 1.3907 of Mahindra & Mahindra Ltd.

Appendices:

Appendix 1 to 4. Revaluation of Output of Automobile Sector Companies

Appendix 1

Revaluation of Output of Bajaj Auto Ltd. from 2010-11 to 2017-18.

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
		Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs
1	Revenue from Operations	16398.23	19528.98	17927.60	19997.25	17177.64	20149.51	16442.00	21612.01	17419.28	22687.59	18989.51	21766.68	17913.98	25164.92	20106.77
2	Other Income	576.51	608.04	558.18	795.49	683.33	706.41	576.43	582.42	469.43	913.27	764.41	1221.97	1005.68	1347.25	1076.45
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	-82.79	-94.15	-86.43	24.00	20.62	-18.90	-15.42	-57.56	-46.39	63.45	53.11	-43.68	-35.95	9.68	7.73
	Total Output	16891.95	20042.87	18399.35	20816.74	17881.58	20837.02	17003.01	22136.87	17842.32	23664.31	19807.03	22944.97	18883.71	26521.85	21190.96

Appendix 2

Revaluation of Output of Mahindra & Mahindra Ltd. from 2010-11 to 2017-18.

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
		Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs
1	Revenue from Operations	23460.26	31853.52	29241.53	40441.16	34738.96	40508.50	33054.94	38444.83	30986.53	40884.98	34220.73	44053.50	36256.03	48685.55	38899.75
2	Other Income	434.15	465.79	427.60	549.17	471.74	717.99	585.88	848.94	684.25	854.85	715.51	1345.46	1107.31	1036.36	828.05
3	Changes in Inventories of Finished Goods, Work in progress, Stock in Trade and manufactured components	-202.23	-597.33	-548.35	-78.03	-67.03	-274.67	-224.13	323.63	260.85	-215.80	-180.62	57.87	47.63	194.87	155.70
	Total Output	23692.18	31721.98	29120.78	40912.30	35143.67	40951.82	33416.69	39617.40	31931.62	41524.03	34755.61	45456.83	37410.97	49916.78	39883.51

Appendix 3

Revaluation of Output of Maruti Suzuki India Ltd. from 2010-11 to 2017-18.

Base year 2010-11 Amount in ₹ crore

S.No	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
		Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs
1	Revenue from Operations	36618.40	35587.10	32668.96	43587.90	37442.01	43700.60	35659.69	49970.60	40276.30	57746.30	48333.65	68034.80	55992.64	79762.70	63730.40
2	Other Income	508.80	826.80	759.00	812.40	697.85	822.90	671.49	831.60	670.27	461.90	386.61	2300.10	1892.98	2045.50	1634.35
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	-56.00	-131.20	-120.44	23.40	20.10	18.50	15.10	-455.90	-367.46	6.90	5.78	-380.10	-312.82	40.70	32.52
	Total Output	37071.20	36282.70	33307.52	44423.70	38159.96	44542.00	36346.27	50346.30	40579.12	58215.10	48726.04	69954.80	57572.80	81848.90	65397.27

Appendix 4

Revaluation of Output of Tata Motors Ltd. from 2010-11 to 2017-18.

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
		Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs	Rs
1	Revenue from Operations	47088.44	54306.56	49853.42	44765.72	38453.75	34288.11	27979.10	36301.63	29259.11	42369.82	35463.54	44316.24	36472.27	58831.41	47006.30
2	Other Income	422.97	574.08	527.01	2088.20	1793.76	3833.03	3127.75	1881.41	1516.42	2132.92	1785.25	981.06	807.41	1557.60	1244.52
3	Changes in Inventories of Finished Goods, Work in progress and Traded Goods	-354.22	-623.84	-572.69	-143.60	-123.35	371.72	303.32	-878.82	-708.33	22.94	19.20	-252.14	-207.51	842.05	672.80
	Total Output	47157.19	54256.80	49807.74	46710.32	40124.16	38492.86	31410.17	37304.22	30067.20	44525.68	37267.99	45045.16	37072.17	61231.06	48923.62

Appendix 5 to 8. Revaluation of Material Input of Automobile Sector Companies

Appendix 5

Revaluation of Material Input of Bajaj Auto Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**															
1	Raw Material Consumed	11311.89	13445.54	12343.01	13523.74	11616.89	12936.47	10556.16	13752.79	11084.75	13717.01	11481.14	13285.36	10933.85	15999.16	12783.33
2	Packing Material Consumed	210.09	273.30	250.89	255.41	219.40	268.65	219.22	312.80	252.12	309.38	258.95	244.85	201.51	269.18	215.07
	Total (A)	11521.98	13718.84	12593.90	13779.15	11836.29	13205.12	10775.38	14065.59	11336.87	14026.39	11740.09	13530.21	11135.36	16268.34	12998.4
(B)	**Stores and Spares Consumed**	85.00	110.25	101.21	123.85	106.39	124.98	101.98	131.69	106.14	131.80	110.32	114.63	94.34	117.71	94.05
(C)	**Purchases of Traded Goods**	568.41	751.15	689.56	858.83	737.73	959.10	782.63	1154.57	930.58	1276.40	1068.35	1382.47	1137.77	1401.25	1119.60
	Total Material Input (A+B+C)	12175.39	14580.24	13384.66	14761.83	12680.41	14289.2	11659.99	15351.85	12373.59	15434.59	12918.75	15027.31	12367.48	17787.3	14212.05

Appendix 6

Revaluation of Material Input of Mahindra & Mahindra Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	**Raw Material And Components**	14708.94	18804.52	17262.55	20749.87	17824.14	21630.08	17650.15	20272.48	16339.62	19373.16	16215.33	21129.65	17389.70	23265.31	18588.98
(B)	**Stores and Spares(Tools) Consumed**	138.71	161.84	148.57	172.72	148.37	182.44	148.87	179.79	144.91	153.05	128.10	161.29	132.74	179.99	143.81
(C)	**Purchase of Stock in Trade**	1757.23	5292.58	4858.59	9752.68	8377.55	8076.92	6590.77	7359.37	5931.65	10409.26	8712.55	10893.63	8965.46	10674.47	8528.90
	Total Material Input (A+B+C)	16604.88	24258.94	22269.71	30675.27	26350.06	29889.44	24389.78	27811.64	22416.18	29935.47	25055.99	32184.57	26487.90	34119.77	27261.70

Appendix 7

Revaluation of Material Input of Maruti Suzuki India Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	Raw Material And Components	27141.80	26707.00	24517.03	30349.20	26069.96	28898.90	23581.50	32867.80	26491.45	35706.90	29886.68	42629.60	35084.16	44941.30	35908.10
(B)	Stores and Spares Consumed	70.20	91.10	83.63	186.40	160.12	164.70	134.40	180.10	145.16	214.00	179.12	224.10	184.43	236.20	188.72
(C)	Purchases of Stock in Trade	1278.10	1532.50	1406.84	2186.40	1878.12	2431.40	1984.02	2665.20	2148.15	3126.40	2616.80	4482.10	3688.77	9993.00	7984.41
	Total Material Input (A+B+C)	28490.10	28330.60	26007.49	32722.00	28108.20	31495.00	25699.92	35713.10	28784.76	39047.30	32682.59	47335.80	38957.36	55170.50	44081.23

Appendix 8

Revaluation of Material Input of Tata Motors Ltd. from 2010-11 to 2017-18

Base year 2010-11 Amount in ₹ crore

S.No.	Items	2010-11	2011-12		2012-13		2013-14		2014-15		2015-16		2016-17		2017-18	
		Actual	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued	Actual	Revalued
(A)	Raw Material And Components	27058.47	33894.82	31115.44	27244.28	23402.84	20492.87	16722.18	22155.23	17857.12	24313.08	20350.05	27651.65	22757.31	37080.45	29627.28
(B)	Stores and Spares(Tools) Consumed	625.45	753.02	691.27	655.67	563.22	497.90	406.29	447.36	360.57	470.94	394.18	653.61	537.92	639.35	510.84
(C)	Purchase of products for sale	7363.13	6433.95	5906.37	5864.45	5037.56	5049.82	4120.65	5765.24	4646.78	5259.27	4402.01	3945.97	3247.53	4762.41	3805.17
	Total Material Input (A+B+C)	35047.05	41081.79	37713.08	33764.40	29003.62	26040.59	21249.12	28367.83	22864.47	30043.29	25146.23	32251.23	26542.76	42482.21	33943.29

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1. Annual Reports of Bajaj Auto Ltd. from 2010-11 to 2017-18.
2. Annual Reports of Mahindra & Mahindra Ltd. from 2010-11 to 2017-18.
3. Annual Reports of Maruti Suzuki India Ltd. from 2010-11 to 2017-18.
4. Annual Reports of Tata Motors Ltd. from 2010-11 to 2017-18.
5. Wholesale Price Index from the website of Reserve Bank of India

Annexure

List of Research Papers Presented in Conferences/Seminars

S. No.	Paper Title	International/ National	Conference Topic	Organised By	Place	Date and Year
1	Labour Productivity in Energy Sector Companies Included in Nifty 50: An Empirical Study	International	42nd All India Accounting Conference and International Seminar on Accounting Education and Research	Department of Accounting, Faculty of Commerce and Management Studies, Jai Narain Vyas University, Jodhpur, Rajasthan and Indian Accounting Association, Jodhpur Branch	Jodhpur, Rajasthan	28-29 December, 2019.
2	Measurement of Material Productivity: A Case Study of Automobile Sector Companies Included in Nifty 50.	International	First International Conference on "Corporate Governance: Issues, Challenges and Changing Paradigms"	Global Research Foundation for Corporate Governance at India International Centre, New Delhi	New Delhi	07-08 September, 2019.
3	Measurement of Material Productivity: A Case Study of Pharmaceutical Sector Companies Included in Nifty 50.	International	41st All India Accounting Conference and International Seminar on "Accounting Education and Research"	School of Business and Commerce, Manipal University, Jaipur and Indian Accounting Association, Sanganer Branch, Jaipur, Rajasthan.	Jaipur, Rajasthan	05-06 January, 2019.
4	Measurement of Labour Productivity: A Case Study of Cipla Ltd.	International	Modern Management Strategies E-Commerce and Global Economy - In Indian Context	Inspira Research Association (IRA) and LBS PG College, Jaipur, Rajasthan	Jaipur, Rajasthan	02-03 February, 2018.
5	Measurement of Material Productivity: A case study of Cipla Ltd.	International	40th All India Accounting Conference and International Seminar on "Accounting Education and Research"	University College of Commerce and Management Studies, Mohanlal Sukhadia University, Udaipur in association with Janardan Rai Nagar Rajasthan Vidyapeeth (Deemed) University and Indian Accounting Association, Udaipur Branch	Udaipur, Rajasthan	18-19 November 2017.
6	Productivity Accounting: An Overview.	National	Frontier Global Economy: Issues and Challenges in New Millennium	BVM College of Management Education	Gwalior, Madhya Pradesh	19 June, 2016.