ASPECTS OF GROWTH AND PRODUCTIVITY:
INDIAN ECONOMY, 1995-2011

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BY

D P PRIYADARSHI JOSHI

SCHOOL OF ECONOMICS

UNIVERSITY OF HYDERABAD

HYDERABAD - 500046

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Abbreviations

AGR	Annual Growth Rate
ASI	Annual Survey of Industries
CAGR	Compound Annual growth Rate
CC	Cumulative Causation
C-D production function	Cobb-Douglas Production Function
CES	Constant Elasticity of Substitution
CPI (IW/AL)	Consumer’s Price Index (Industrial Workers/Agricultural Labour)
CSO	Central Statistics Office
C W Index	Chenery- Watanbe Index
DD	Double Deflation
DGE & T	Directorate General of Employment & Training
D W Statistics	Durbin-Watson Statistics
EPWRF	EPW Research Foundation
FC	Fixed Capital
FTA	Free Trade Agreements
OLS	Ordinary Least Squares
GAA	Growth Accounting Approach
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
IAMR	Institute of Applied Manpower Research (Now known as , National Institute of Labour Economics Research and Development)
IOTT	Input Output Transaction Table
LPG	Liberalisation, Privatisation and Globalisation
NAS	National Accounts Statistics
NCS	Net Capital Stock

NDP	Net Domestic Product
NIC	National Industrial Classification
NIOT	National Input Output Table
NSSO	National Sample Survey Office
NVA	Net Value Added
NVAR	Net Value Added (Real)
PIAM	Perpetual Inventory Accumulation Method
SD	Single Deflation
TEXPROCIL	Textile Export Promotion Council
TFP	Total Factor Productivity
TFPG	Total Factor Productivity Growth
TUFS	Technological Upgradation Fund Scheme
VS	Vertical Specialisation
WIOD	World Input Output Database

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Introduction

1.1 Background

For the mankind to be provided with the material needs for survival, a system of production is a prerequisite. It is a historical fact that some countries are unable to meet even the basic needs whereas peoples in western capitalist developed countries have access to the high standards of living. From the beginning of economic writings, the questions of growth and inequality between countries have been addressed. The issue of inequality went even deeper to the level of distribution of income.For more than two centuries since Adam Smith's *The Wealth of Nations*, Economists have been asking the question of 'How do economies grow?' There are several models of growth, but the simplest of all can be located in Smith's magnum opus. Improvements in standard of living are reflected in higher per capita incomes. Smith pointed that out per capita income is nothing but the multiplication of labour productivity and the proportion of employed to the total population. So the explanation of growth in national income can be located in either growth in labour productivity or the growth of employment.

$$\frac{Y}{N} = \frac{Y}{E}\frac{E}{N} \qquad (1)$$

Where, Y = Output/Income, N= Total Population, E = Employment.

Thus growth in labour productivity has been vital in the capitalistic development. Equation (1) provides a decomposition of growth in per capita income in terms of productivity growth and employment growth. Conventional studies on productivity are in the spirit of the neoclassical theory of distribution (Shmookler, 1952; Abramovitz, 1956; Solow, 1957; Kendrick, 1961; Jorgenson and Griliches, 1967). This literature refers to the growth and trends of productivity in the United States. Most of the studies have concluded that much of the source of growth in output remains unanswered by growth in inputs. The realised gap between output growth and input growth has been conceptualised differently by different economists. The theories underlying these studies do not hold empirically. Again, as the marginal productivity theory has been discredited for longbeing at the centre of 'Capital Theory', the current empirical studies rely increasingly on the advanced econometric tools. Given the basic structure of neoclassical theory, these studies are necessarily base on two premises. First, individual factors should get a certain imputed share in a product. Secondly, the shift in the technological frontier of an economy is independent of factor accumulation. A number of studies examine the dynamics of productivity growth, and most of them are centered on the concept of total factor productivity. The neoclassical theory that backs these studies is based on much-debated assumptions like constant returns to scale, perfect competition, continuous Solow-type production function, smooth substitution between factor inputs and so on.

In contrast to this neoclassical analysis of productivity, Smith's classical approach to the problem of productivity growth has remained majorly dormant. The classical approach places the problem of productivity of labour at the centre of economic growth and accumulation. In fact, the productivity of labour and growth are bound together in a circular and cumulative process of change. There is no logical separation between labour and non-labour means of production, and also there is no logical connection between income distribution and productivity as such. Thus the classical approach affords a better guide towards policy making by lending distinct way of analysing the forces underlying productivity. The present study seeks to analyse the productivity rise through a classical approach and confront it empirically to establish its promise and efficacy.

The smooth substitution between labour and capital is also erroneous. Sraffa writes, "The marginal approach requires attention to be focused on change, for without change either in the scale of an industry or in the 'proportions of factors of production' there can be neither marginal product nor marginal cost. In a system in which, day after day, production continues unchanged in those respects, the marginal product of a factor (or alternatively the marginal cost of a product) would not merely hard to find- it just would not be there to find." (Sraffa, 1960: preface)The substitution of factors is immaterial in the sense that for a certain economic production system the factors become complementary to each other.

The problem of productivity of labour, in classical economics, does not presume that labouralone can produce output. But productivity stands for productivity of assisted labour. Productivity is determined by the division of labour.[1]Skill, dexterity and time-saving elements increase productivity. Division of labour depends upon the extent of the market, so that the larger the total population, the greater the differentiation of production both concerning processes and products. The cumulative causation theorists develop a circular causation between increasing returns and extent of market. The classical tradition has concluded that agriculture is subject to

[1] Smith (1776: 6).

diminishing returns and industry is subject to increasing returns. As land is limited, it will govern the future returns to scale and the limiting nature of factors is the basis of diminishing returns.[2] Young (1928) states, "The Division of labour depends upon the extent of market, but the extent of market also depends upon the division of labour."[3] Young's conceptualization of Division of Labour can be traced back to the literature to Smith's. Because of the presence of economies of scale, agglomeration of small firms takes place to reap the advantage of new opportunities and acquire new markets. A few products can only survive in the competition. Moreover, the manufacturing sector is oligopolistic in nature. The neoclassical production function presupposes disembodied technical progress. But as far as the classical and cumulative causation theories are concerned, technical progress is embodied in capital goods. Kaldor’s technical progress function (Kaldor, 1957) thus relates the rate of growth of output per worker to the growth rate of capital per worker. The shape of the function is dependent on the degree of embodiment of new technology into capital accumulation. So technology is always unpredictable, and that makes the whole economic system unforeseeable.

The stylised facts of capitalist development are observed by Kaldor (1996). Firstly, there is steady trend rate of growth of labour productivity. Secondly, there is a steady increase in capital intensity. Thirdly, the rate of profit on capital is stable. Fourthly, there is relative constancy of capital-output ratio. Fifthly, there are a relatively stable factor shares. And finally, there is a wide gap in the growth of productivity and output between different economies with same capital-output ratio and same distributive shares.[4]All these facts or tendencies of capitalist development cannot be based on some sterile assumptions like disembodied technical progress, constant returns to scale, unitary elasticity of factor substitution. Kaldor’s idea of growth negates any meaningful distinction between the shift in the production function and movements along a function. The Technical progress needs investment and new capital always embody innovations. Thus technical progress function relates labour productivity growth to capital intensity growth, and the shape of the function depends on the degree of the embodiment.

The Smithian generalisation of the Division of labour depending upon the extent of the market is the basis for Young to build his theory upon. The increase in the capital-labour ratio as

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[2]Kaldor (1996: 111-12).

[3] Young (1928:530).

[4]Kaldor (1996: 175).

a result of splitting up of occupations and division of the complex processes into smaller and simpler separate processes gives rise to more specialised machines. The greater division of labour and roundabout production process can only be profitable if the scale of production exceeds a certain level. The causation pursued by Smith is one dimensional, but Young depicts division of labour and growth of market to be bounded in a circular and cumulative causation. So that extent of market is also determined by division of labour.[5] The distinct feature of capitalist growth is the capital accumulation and embodied technology. The operation of scale economies encourages new capital investment and the introduction of new machines. A growing market gives rise to output growth and therefore productivity growth.[6]

Against the theoretical background given above, Indian studies are centred on the conventional framework. Most of the productivity studies concentrate on TFP growth in the post liberalisation era and that too in the organised manufacturing sector. The studies are designed to look into influence of reforms and determinants of productivity growth. Studies found industrial growth in India as well as in developing nations had no connection with productivity growth (Brahmananda, 1984; Krishna, 1987; Ahluwalia, 1986 and 1991; Goldar, 1986). Ahluwalia (1991) concluded negative TFP growth in the pre-80's period but grew at a higher rate since the 1980's. Another set of literature examined the effect of liberalisation on TFP growth (Goldar, 2002, 2004 and 2007; Goldar and Kumari, 2003; Mitra, 1999). The studies credited higher level of TFP growth to reforms. Balakrishnan and Pushpangadan (1994, 1998, and 2002) have refuted the conclusion after using double deflation method and found no TFP growth in the post-reforms period. The studies are involved in the estimation of TFP growth through growth accounting method or econometric estimation of the production function. However, recently Balakrishnan (2010) has noted the vulnerability of the approach of growth accounting.[7] Also, the exercise of the fitting production function for the Indian economy has been carried on by some researchers (Mehta, 1980; Bashin, V., and Seth, V. 1977, and 1980; Bhandari, P. 2013). These studies, except for Bhandari, have concluded that the specification of Cobb-Douglas production function for the Indian Economy and different sectors misrepresent the growth process. The studies also suggest they are unable to report the correct values of substitution parameter, scale parameter

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[5]Smith (1776: 18), Young (1928: 531).

[6]Verdoorn(1949).

[7]A detailed description has been made in the subsequent Chapter 2 of the thesis.

and efficiency parameter; however, the CES production function is flexible enough to represent these strategic parameters. These studies never stopped estimating production functions even when the authors are awake.

Few studies are found to use a different approach analysing productivity. For example, analysis of productivity using the input-output transaction table (IOTT) can be valuable. Steedman & Gupta (1971) have used the British Input-Output Table to analyse productivity growth in the British economy. The 'direct labour productivity', that is labour productivity of individual sectors considered separately, according to them overestimates the actual productivity rise as they do not take into account the dependency of the sectors. It is only the 'system labour productivity' which also incorporates interdependencies in production structure of the whole economy, that gives us a realistic picture.. System labour productivity analysis not only gives the factors of change in productivity but also is helpful in finding the employment potential of the sectors. Similarly, Hazari and Krishnamurthy (1970) used the Input-output table prepared by Perspective Planning Division of the Planning Commission for the year 1965 to analyse the employment potential of the economy. The applications of IOTT are numerous in analysing different aspects of productivity growth like they can be used in linkages, multiplier effects, structural changes and so on.

1.2 Research gap

It is clear that the predominance of neoclassical approach in the study of productivity growth and economic growth leads to unsatisfactory results. Thus, I locate a gap in the literature to accommodate a classical analysis of productivity growth which would give more transparency to policy making. As mentioned, Input-Output methods can be used to analyse labour productivity. I do the same for India. Also, the IOTT has not been used to analyse the employment scenario for long, so I have taken the opportunity to look at the problem of sectoral employability.

1.3 Study objectives

The objectives of the study are:

1. To get the empirical estimates of the productivity growth from conventional approaches to measurement of productivity i.e. growth accounting approach and production function approach.
2. To examine the trends and growth rate of labour productivity and the factors affecting labour productivity growth.
3. To examine the impact of trade on employment generation and productivity growth.
4. To propose a measure of system labour productivity for different sectors and examine its implications for the structure of the economy and employment.

1.4 Data and methodology

Period of study

The study period chosen is post-reform (or post-1995) years after making allowance for availability of relevant data sets. This period, as well-known, has seen a significant rise in Indian growth rate. In particular, the Input-Output Tables prepared by World Input-Output Database (WIOD) are available for the period 1995 to 2011.

Databases

Major databases used in the study are National Input-Output Table prepared by WIOD, National Accounts Statistics (NAS), Annual Survey of Industries (ASI), National Sample Survey Office (NSSO) reports and employment data published by Directorate General of Employment & Training (DGE & T). The Consumer Price Index for industrial worker and for agricultural labour is taken from Labour Bureau. GDP Deflator is calculated from National Accounts Statistics (NAS).

National Input-Output Table for India prepared by WIOD is the prime data source used in the study. The Database gives input-output table for India from the year 1995 to 2011. To make it compatible with Standard Industrial Classification and to facilitate cross-country comparison, the whole input-output table is constructed in the order 35*35. But to make it compatible with

National Accounts Statistics for India, the sectors are aggregated into 17 industry groups (Name of Industry Groups is listed in Table 1.1).[8]

Table 1.1: Aggregated Industry Groups

NIC Code, 1998	Industry Group	NIC Code, 1998	Industry Group
A+B	Agriculture & allied activities (Agriculture, Hunting, and Forestry: Fishing	26	Non-Metallic Mineral Product
C	Mining and Quarrying	27+28+29+30	Basic Metal Product
15+16	Food Processing (Food & Beverages; and Tobacco)	31+32+33	Electrical and Optical Equipment
17 + 181	Textile Product	34+35	Transport Equipment
182+19	Leather Product	369+37	Manufacturing nec. and Recycling
20+361	Wood Product	E	Electricity, Gas & Water Supply
21+22	Paper Product	F	Construction
23+25	Rubber, Plastic and Petroleum Product	G- Q	Services
24	Chemical Product		

National Accounts Statistics (NAS) is published annually by Central Statistics Office (CSO) of Ministry of Statistics and Programme Implementation (MOSPI). It is a key database on macroeconomic data. Gross Domestic Product (GDP), capital formation, and consumption are available in this database for both public & private sector as well as for different sectors according to economic activities. NAS also gives data on factor incomes.

Annual Survey of Industries (ASI) is the principal source of data for registered manufacturing in India. It is published every year by Central Statistics Office (CSO) of Ministry of Statistics and Programme Implementation (MOSPI). The EPW Research Foundation (EPWRF) has produced two volumes of concordance and consistence time series database on ASI for the period 1973-74 to 1998-99 and 1973-74 to 2003-04. In the second volume, the data are made consistent with National Industrial Classification (NIC) of 1998. For the period 1980-

[8] A note on the NIOT for India by WIOD is given in the Appendix to Chapter 2.

81 to 2003-04, the data of the volume have been collected and for the remaining years i.e. from 2004-05 to 2012-13 the data are collected from the summary results of ASI available on the website of the MOSPI.

For employment data, NSSO Quinquennial Rounds on Employment. NSS 68th Round, 61st Round, 50th Round and 38th Round survey report on Employment and Unemployment Situation in India are used in the study. For organised sector employment, data have been collected from Directorate General of Employment & Training (DGE & T).

Variables

Output: -

In Chapter 2 and Chapter 3, value added is taken from the NIOT by WIOD and is deflated by GDP deflator at 2004-05 prices to get Value added from single deflation (VASD). In case of value added from double deflation, the value of intermediate inputs are deflated by separate material price index at 2004-05 prices and the resulting value is deducted from the real gross output (Gross output deflated by GDP deflator at 2004-05 prices). The material price index is a weighted index of GDP deflators of inputs, the weights being calculated from NIOT published by WIOD.[9] For registered manufacturing the net value added data is taken from Annual Survey of Industries (ASI).

For Chapter 4, NDP at 2004-05 prices for the different sectors are taken from NAS. Net Value Added data for Registered Manufacturing is used from Annual Survey of Industries (ASI). In the calculation of labour productivity (both industry and system), gross output deflated by GDP deflator at 2004-05 prices has been used in Chapter 4 and Chapter 5.[10]The Gross Output data is taken from NIOT published by WIOD.

[9] A detailed method of Double deflation is given in the appendix of Chapter 2.

[10]Here arises a question whether to use value added or gross output. The answer to this question is: (i) The value added based measure reflects an industry's capacity to translate technical change into income and a contribution to final demand. The gross output based productivity measures are less sensitive to the degree of outsourcing. (ii) In comparison to the labour productivity based on gross output, the growth rate of value added based labour productivity depends less on the changes in the ratio between intermediate inputs, labour or the degree of production networking. This lead to a fall in the value added based labour productivity measures tend to be less sensitive to the process of substitution between materials plus services and labour than gross output based measures.

But in this study as Input-Output table is used to estimate productivity, the gross output has been taken as a proxy for output. The trend of both value added, and gross output for all the sectors is examined, and it shows a parallel trend between the two.

Labour:-

Total person engaged data is collected from Socio-Economic Accounts published by WIOD. For registered manufacturing, total person engaged data is taken from Annual Survey of Industries (ASI). In Chapter 4, employment data is collected from NSSO reports. Employment is taken as both Principal Status and Subsidiary Status (PS+SS). For organised sectors, the employment data source is Directorate General of Employment and Training.

Capital:-

In Chapter 4, Net Capital Stock data are collected from NAS. Also for registered manufacturing, data on fixed capital is taken from Annual Survey of Industries.[11]

For analysis in the subsequent Chapter 2, 3 and 5, real fixed capital stock at 1995 prices is collected from Socio-Economic Accounts published by WIOD. It is converted to real fixed capital stock at 2004-05 prices by the method of Splicing.

Factor payment:-

Labour Compensation and Capital Compensation data are drawn from Socio-Economic Accounts published by WIOD. For the registered manufacturing, ASI gives the data on Labour compensation, Profit, Rent Paid and Interest paid.

Deflators used

There are three deflators used in this study to correct for inflationary effect. GDP deflator with the base year 2004-05 is used to deflate variables like value added, output and Capital Stock, exports, imports; Consumer price Index (CPI) for the industrial worker and Agricultural Worker at 2000-01 is used to deflate the labour compensation.

[11]The fixed capital in the ASI is given in book value. So the fixed capital does not represent the value of fixed capital used in the production process at present. To avoid this undervaluation of capital, the capital stock by applying the Perpetual Inventory Accumulation Method (PIAM) is to be estimated. But in this study, the researcher refrain from applying the PIAM as the methodology for using the method is not clear. Different studies applied PIAM with various benchmark year, different assumption on depreciation rate and different longevity of machines and fixed capital. As the fixed capital consists of different forms of capital, it may not be possible to aggregate them into one uniform depreciation rate and longevity. However, it is also found that the net capital stock estimated from PIAM and fixed capital from ASI gives a parallel trend. So fixed capital collected from ASI is used in the study.

Other methodology used in the study

In the study different methodologies have been used according to the requirement of the analysis. The different econometric tools and methods used are precisely represented in the appendix of the chapter concerned. Different models used in the study are Ordinary Least Squares (OLS), Semi-Log Linear model and Double-Log Linear model. These models are used to establish relationships between the economic variables used in the study.

Growth rates

Three types of growth rates; such as annual growth rate (AGR), Compound annual growth rate (CAGR) and Trend Growth Rate (TGR) have been used in this study.

The Annual Growth Rate is the growth of that variable on an annual basis. It is calculated as:

$$g_t = \frac{y_t - y_{t-1}}{y_{t-1}}$$

Here, g = growth rate, y = Variable, t = time.

CAGR is calculated as:

$$CAGR = [\{(end\ value/initial\ value)^{\frac{1}{n-1}}\} - 1] * 100$$

On the other hand, Trend Growth Rate is calculated by fitting a semi-log regression line. The equations estimated are of the form: $\log Y = a + bT$, here Y is the variable, and T refers to the number of years in the period for which the growth rate is calculated. Then in the second step, antilogarithm of the relevant coefficient minus one gives TGR.

Splicing:

Splicing is a method of combining two or more overlapping series of index numbers to obtain a single continuous series to facilitate comparisons.

1.5 Chapter plan

The thesis consists of six chapters. Chapter 1 is the introduction, and it provides a backdrop to the study followed by objectives, hypotheses, methodology, data sources and chapter plan. In the background of the study this chapter delineates a critical as well as constructive description towards building a classical proposition related to the productivity growth. Chapter 2 and Chapter 3 explore theoretical as well as empirical flaws of the conventional approaches to measurement of productivity. Chapter 2 explicitly discusses the growth accounting approach while the production function approach is discussed in Chapter 3.The trends and growth of the labour productivity and the factors affecting the growth of labour productivity are also analysed in chapter 4. In chapter 5, an alternative to direct labour productivity is presented. The trend analysis and also the factors of changes in the system labour productivity is analysed. An attempt to show the employment potential of sectors, have been made in the chapter. Finally, Chapter 6 outlines the summary and conclusion of the study followed by policy implications.

Conventional Approach to Measurement of Productivity-I (Growth Accounting Approach)

2.1 Introduction

One of the dominant approaches to measure productivity growth is the Growth Accounting Approach (GAA). It assumes output growth can be decomposed as the weighted sum of input growths. If the weighted sum of the input growths does not add up to output growth, then the difference is taken as Total Factor Productivity (TFP) growth or a measure of Technical Progress. The weights given to the inputs are the factor distribution shares measured by the marginal productivity of the factors. So the approach is based on the neoclassical theory of distribution. The present chapter deals with the measurement of productivity through Growth Accounting Approach while Production Function Approach will be discussed in the subsequent Chapter 3. The underlying objective of the chapter is to examine the conventional approach theoretically as well as empirically.

Section 2.2 of the chapter gives a detailed explanation of the GAA. Section 2.3 contains the long-standing critical arguments not only between the admirers of classical economics and neoclassical economists but also the internal neoclassical debate on the measurement of inputs. In Section 2.4, the problem of double deflation is explained. Section 2.5 and Section 2.6analyse the estimates of TFP growth from Growth Accounting Approach. Section 2.7 gives a brief summary of the chapter. The data used in the chapter are taken from National Input-Output Table for India and Socio-Economic Accounts published by WIOD and the Annual Survey of Industries for Registered manufacturing sector.

2.2 Growth accounting approach

Growth accounting is applied to time-series data on output and input growth to calculate growth in the residual known as technical change. The residual in the estimation may be due to measurement error, omitted variables, aggregation bias and model specification. The method demands the decomposition of growth in output into contributions of input accumulation and technical change. The application of growth accounting may go wrong when the method is undertaken without ascertaining the form of production function underlying the data.

Growth accounting method is designed to measure the proximate sources of increase in output. This method is based on the assumption of separability of factor inputs as it is very natural to believe that factors are feeding one another in the production process. Mutual interdependence between the growth of inputs and growth of technological progress adds to the limitation of growth accounting as a method. Again, the assumption ‘technical progress is costless’ by growth accounting is incorrect. Most of the advances in knowledge, technical innovation, improvement of skills, and training are compensated. The capital theory debates, popularly known as the Cambridge capital controversies, raised the problems associated with measuring capital. Being a heterogeneous factor of production, one can only estimate capital by multiplying its quantities with its prices. Labour, on the other hand, has a natural unit of measurement – such as man days and can be measured independently of its price. The index to represent aggregate capital cannot be formulated because of its heterogeneous nature.[1]The application of this methodology to US data, yielded bewildering results as it was found that only a small fraction of output growth could only be attributed to input growth. Abramovitz (1989) claimed that the enhancement of productivity of the factor and management skill should involve expenditure. So the expenditure might reduce the value of residual. Further, any errors in measurement of data would affect the residual. Abramovitz also found that alternative definitions of output and capital resulted in variedly different estimates.[2]

The crux of the GAA is the separation of change in production on account of change in the quantity of factors of production from residual influences, viz., technological progress, learning by doing, managerial efficiency, etc. TFP growth proxies these residual influences. The applications of GAA can be dated back to Tinbergen (1942) and Solow (1957). There are many ways of measuring total factor productivity through Growth Accounting Approach but the three indices those are often used are: (i) Kendrick's arithmetic index (Kendrick, 1961); (ii) Solow's index (Solow, 1957); and (iii) Translog Index (Christensen and Jorgenson, 1973). In this present study, TFP growth is estimated through these indices. Most of the studies have used

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[1] See Section 2.3 in this chapter.

[2]Abramovitz (1989: 24).

Translogindex to estimate on TFP growth in India.[3] The Kendrick index and Solow index are also estimated to compare the results. A detailed discussion of these three indices is presented below.

2.2.1 Kendrick's arithmetic index[4]

Kendrick index measures total factor productivity using a distribution equation derived from homogenous production function and the Euler condition. The index is interpreted as the ratio of actual output to the output, which would have resulted from increased inputs alone, i.e., in the absence of technological change. Kendrick index for TFP (At) for the period't' will be:

$$\frac{dA}{A} = \frac{Q_1/Q_0}{(wL_1+rK_1)/(wL_0+rK_0)} - 1 \qquad (1)$$

where 'w' and 'r' denote the factor rewards to labour and capital respectively in the base year '0'.

Income shares are used as weights to compute the ratio of output to a weighted combination of inputs. It is to be noted that use of these weights entails to the assumption that factor rewards are equal to their marginal productivity. In other words, the applicability of marginal productivity theory of distribution is assumed. Second, technological change is of Hicks-neutral type. In the case of Hicks-neutral technical change the marginal rates of technical substitution remain unchanged and the technical progress increases the output attainable from a given bundle of inputs. The third assumption is that of constant returns to scale. In brief, the assumption of constant returns to scale combined with the applicability of marginal productivity theory yields the product exhaustion or the Euler's theorem, which means that entire output is exhausted by payment made to labour and capital. Thus, in the base year, A_0 will be equal to unity by definition.

One of the major limitations of the Kendrick Index is that it is based on a linear production function (and hence, an infinite elasticity of substitution between the factors of

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[3]See, Ahluwalia, 1991; Balakrishnan and Pushpangadan, 1994; Rao, 1996; Pradhan and Barik, 1998; Trivedi et al., 2000; Goldar and Kumari, 2003

[4]See, Kendrick (1961).

production) and does not allow for the diminishing marginal productivity of factors of production.

2.2.2 Solow'sindex[5]

Solow (1957) represents the aggregate production function as:

$$Q = F\ (L, K; t) \tag{2}$$

where Q represents output, L and K represent labour and capital inputs in physical units and t for time to allow technical change. The term technical change represents the slow downs, speed ups, improvements in the education of the labour force and all sorts of things. The shift in the production function is defined to be neutral if marginal rates of substitution remain untouched, but the shift increases or decreases the output attainable from given inputs. So the production function takes the form:

$$Q = A(t)f\ (L, K) \tag{3}$$

Taking the total derivative of Equation (3) on 't,' we will get

$$\frac{dQ}{dt} = \hat{A}\, f(L, K) + A(t)\frac{\partial f}{\partial L}\frac{dL}{dt} + A(t)\frac{\partial f}{\partial K}\frac{dK}{dt} \tag{4}$$

Dividing equation (4) with Q both the side will give,

$$\frac{\hat{Q}}{Q} = \frac{\hat{A}}{A} + A\frac{\partial f}{\partial L}\frac{\hat{L}}{Q} + A\frac{\partial f}{\partial K}\frac{\hat{K}}{Q} \tag{5}$$

So the measure of TFP growth can be written as

$$\frac{\hat{A}}{A} = \frac{\hat{Q}}{Q} - A\frac{\partial f}{\partial L}\frac{\hat{L}}{Q} - A\frac{\partial f}{\partial K}\frac{\hat{K}}{Q} \tag{6}$$

Where, $\hat{Q}, \hat{L}, and\ \hat{K}\ represent\ the\ corresponding\ derivatives\ with\ respect\ to\ time.$

Solow (1957) used a linear Cobb-Douglas production function to obtain the TFP growth. So the Solow residuals are built on all the assumptions of the linearly homogenous C-D

[5] Solow (1957: 314)

production function, viz., disembodied Hicks-neutral technical progress, a unitary elasticity of substitution and Euler's theorem.

The underlying C-D production function will be

$$Q = AL^{\alpha}K^{\beta} \quad (7)$$

The measure is computed as follows:

$$\frac{\hat{A}}{A} = \frac{\hat{Q}}{Q} - \left(\alpha\frac{\hat{L}}{L} + \beta\frac{\hat{K}}{K}\right), \alpha + \beta = 1 \quad (8)$$

where α and βare marginal productivities of labour and capital which are also the shares of labour and capital in the value added respectively.

$\hat{Q}, \hat{L}, and\ \hat{K}\ represent\ the\ derivatives\ with\ respect\ to\ time\ of\ Q, L, and\ K.$

For small changes in quantities of inputs and outputs, this measure approaches Kendrick's index.

The Solow concept of TFP growth is unambiguous for infinitesimally small and continuous shifts in technology across time. Empirical estimates of productivity change are based on a discrete set of price and quantity data. A solution to this problem lies in using a flexible form of production function, which is twice differentiable.

2.2.3 Translog index

The Translog Index (also known as Tornqvist-Theil index) is a superlative index[6], historically advocated by Tornqvist (1936) and Theil (1965) but introduced into the productivity measurement by Christensen and Jorgenson (1973). The index is consistent with the flexible production function and can be applied to discrete data points (Caves, Christensen &Diewert, 1982: 1411).Translog index is consistent with both Homogenous and non-homogenous translog production function. The Translog index is also desirable because of its flexible structure of

[6]. Each form of Index number has an underlying aggregator function. An aggregator function is flexible if it gives a second-order approximation for linearly homogenous function. So an index number is called superlative if it is consistent with a flexible aggregator function.

For details See Diewert (1976)

production not like a restricted structure of production followed by other indices.[7]It not only accommodates discrete time analysis but also imposes fewer a priori restrictions on the underlying technology of production. Another advantage of the Tornqvist-Theil index is that it accounts for changes in quality of inputs. Since current factor prices are used in constructing the weights, quality improvements in inputs reflected in higher wage and rental rates are incorporated (Capalbo and Vo, 1988). The Translog index provides consistent aggregation of inputs and outputs under the assumptions of competitive behaviour, constant returns to scale, Hicks neutrality, and input-output separability.[8]

The function takes the form:

$$TFPG = (lnQ_t - lnQ_{t-1}) - \sum \frac{1}{2}(s_{it} - s_{it-1})\,(lnX_{it} - lnX_{it-1}) \qquad (9)$$

whereTFP Growth represents total factor productivity growth, *Q* denotes output, *Xi* factors of production and s_i share of factors of production in total output at current prices. Most of the recent studies in the Indian context have used the discrete approximation of the Translogproduction function in the form of TranslogIndex (see for example, Ahluwalia, 1991; Balakrishnan and Pushpangadan, 1994; Rao, 1996; Pradhan and Barik, 1998; Trivedi et al., 2000; Goldar and Kumari, 2003).

The above equation (9) is based on a more general neo-classicaltranslog production function for which the elasticity of substitution need not be infinite, equal to unity or even constant. However, the technical change need not be of Hicks-neutral type. Further, if factors are paid their marginal products, TFP growth measured gives the difference between the growth of real output and the rate of growth of factor and raw-material inputs.

The above explanations of the different methods of Growth Accounting Approach (GAA) are based on different restrictive assumptions, and also their applications are narrowed down by these assumptions. The next section describes the theoretical controversies surrounded these methods in a broad way.

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[7] See Craves, Christensen and Diewert (1982a: 79, 1982b:1411)

[8] See Craves, Christensen, and Diewert (1982a: 84)

2.3 Theoretical controversies

The neoclassical distribution theory despite being discredited for long forms the basis of conventional productivity analysis.[9] The problem of Total Factor Productivity makes the agenda which by the neoclassical itself is treated as a residual. Regarding economic methodology, the studies on productivity set up two key problems. First, a given quantum of product must be imputed unambiguously to individual 'factors' of production. Secondly, in a dynamic context, a shift in the economy's technological frontier must be identified independently of factors accumulation. The economic theory that backs the studies on productivity dynamism is mainly based on neoclassical assumptions such as constant returns to scale, perfect competition, continuous Solow-type production function, a smooth substitution between the factors of production. First of all the classical and neoclassical opinions differ on the existence of the concept 'Total Factor Productivity' and moreover the backing of vulnerable assumptions which are far from operational realism, specifically in the case of manufacturing sector. Alongside the mainstream arguments, there is an internal debate flowing within the neoclassical economists itself on the correct measurement of inputs. The problem that covers the argument is the appropriate measure of capital services in the production. Also, the internal argument takes into account the application of distinct approaches such as index number and production function approach in the estimation of total factor productivity. Amid these assumptions and theoretical backdrops, conventional approaches are being used by the researchers in productivity measurement. Here in this section, the theoretical controversies will be discussed.

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[9]The marginal productivity theory concludes that under perfectly competitive equilibrium the factor prices of each input are equal to their marginal products. Some serious problems involved with the theory apart from its unrealistic assumptions raises doubt over its application in the real world. The empirical studies on productivity and production disqualified the notion of constant returns to scale in the long-run (Kendrick, 1961; Abramovitz, 1962; Baily, 1986). Also, the short period relationship between employment and output shows the higher marginal product of labour than the average product (Okun's Law). The absence of aggregation method for capital inputs puts restrictions on the use of aggregate production function. The use of raw materials as a factor of production in the production complicates the situation as the raw material has a positive correlation with the output. So again if the raw materials are included in the inputs then the concept of the marginal product of raw material will come up as in the case of capital and labour.

The theoretical critiques are explained in Section 2.3 of this chapter.

Further see, Robinson (1954), Sraffa (1960: preface), Kaldor (1966:315)

Method of aggregation

The classical and neoclassical controversy in the measurement of productivity has its roots from the presentation of the relationship between output and the inputs. The underlying assumptions of the neoclassical production function provide the basis for a serious string of arguments between the mainstream neoclassical economists and the admirer of the classical school.

The correctness of growth accounting indices in measuring the total factor productivity depends on the successful specification in estimating the parameters of the aggregate production function. The major factors of determinants of factor productivity have been the technical change and the movement of relative factor prices. The technical changes are picturised as the efficiency of production, substitution in the inputs, economies, and diseconomies in production and homotheticity of the production function.The productivity relations involved in the indices are derived from the aggregate production functions which are based on the certain restrictive assumptions. Further, the production functions are of equilibrium concept which is far away from the dynamic forces that cause technical changes.

The aggregate production function involves the aggregate labour and capital indices. But heterogeneity of the units of the inputs does not support the method of aggregation. The labour and capital are heterogeneous in their longevity, impermanence, productive qualities, mobility, etc. Aggregation is only possible when a competitive economy is assumed. The necessary and sufficient conditions for grouping variables are: the rate of substitution between capital goods are independent of the quantity of labour used, and the marginal rate of substitution between the different types of capital must be constant.

But Robinson(1954) and Kaldor (1961) have argued that it is impossible to construct an index of capital.[10] The value of capital is affected by the changes in the relative factor prices, the interest and wage rates. Also, the case of perfect substitutability may not apply because different types of machines may be complementary. Besides, there is the problem of aggregating many technically different microeconomic production functions. Fisher (1969) has demonstrated that

[10] Robinson (1954: 81), Kaldor (1961).

the aggregation of labour, capital and output requires all that capital should be perfectly substitutable and all technical changes are capital-augmenting. A different problem arises when a third factor is introduced into a two-factor production function. Further, there is the question of complementarities between the third and the two original inputs.

Ambiguity on total factor productivity

First of all the classical and neoclassical opinions differ on the existence of the concept ‘Total Factor Productivity'. Moreover, the assumptions like perfect competition, constant returns to scale, continuous Solow-type production function, a smooth substitution between the factors of production on which the concept is based on are far from operational realism in a capitalistic economy and specifically in the manufacturing sector.

> All of the pioneers of this subject were quite clear about the tenuousness of such calculations and that it may be misleading to identify the results as ‘pure' measures of technical progress. Abramovitz worried about possible measurement errors in his labour and capital series, especially the omission of the intangible capital accumulation through education, nutrition, and R & D, and also about not allowing for increasing returns to scale. Kendrick (1956) noted the omission of intangible capital, such as R & D, from his total input construction. Solow (1959) emphasised that he used the phrase ‘technical change' for any kind of shift in the production function….
>
> At this point, the gauntlet had been thrown: even though it had been named ‘efficiency,' ‘technical change,' or most accurately a ‘measure of our ignorance,' much of the observed economic growth remained unexplained. (Griliches, 1996: 1329)

The above paragraph summarizes the ambiguity among the economists regarding the concept of ‘Total Factor Productivity’. TFP does not explain the process of growth. The residual which is known as TFP is also inconclusive as to its source.

Capital as a factor of production

Pasinetti (1959) opined as capital was reproducible, its production process was subjected to change.[11] He also claimed that the nature of capital had been neglected. An extension of Solow's theoretical approach was put forward by including the production of productive capacity. Pasinetti considered both the process of producing final commodities and producing the corresponding productive capacity.

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[11] Pasinetti (1959: 284)

The primary concern of Pasinetti was that as capital came from the production process itself, on which technical change operates, it could not be dealt with in the same way as labour and land. The differentiation of the production of consumables and the production of capital goods had been ignored as Solow wanted to confine himself to a simple capital model.[12]

Measurement of capital inputs

Apart from the production function controversy, the internal neoclassical debate regarding the appropriate measurement of inputs in the process of production and the allocation of the contribution of factors to the economic growth found a new stream of research. The main contributors to the debate of the measurement of input were Jorgenson D W, Denison E, Kendrick J W, Domar E, Griliches Z. But to start with the quote below shows the conventional neoclassical approaches do not worry about the measurement of capital.

> Moreover, the production function has been a powerful instrument of miseducation. The student of economic theory is taught to write O= f(L, C), where L is a quantity of labour, C a quantity of capital and O a rate of output of commodities. He is instructed to assume all workers alike, and to measure L in man-hours of labour, he is told something about the index-number problem involved in choosing a unit of output; and then he is hurried on to the next question, in the hope that he will forget to ask in what units C is measured. Before ever he does ask, he has become a professor, and so sloppy habits of thought are handed on from one generation to the next. (Robinson, 1954)

The contribution of capital input to the measured productivity change dominated the theme of proper input measurement.[13] Jorgenson and Griliches (1966) tried to develop capital theoretic methods to the measurement of capital input. They went further to state that the errors in the measurement of inputs were the major source of productivity change in the US economy which overstates the proportion of growth assigned to the residual.

The construction of quantity index of total capital inputs has been less straightforward as the whole transaction of capital services is recorded internally in the individual units. First, the problem of calculation begins with the values of the new investment goods for which the prices and quantities of investment goods are essential. Secondly, the quantity of fresh investment goods net depreciation must be added to the accumulated stocks. Finally, the amount of capital

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[12] Solow (1959:282)

[13] Jorgenson and Griliches (1966: 52).

services corresponding to each stock need to be calculated. It is very much important to keep in mind that an error in the measurement of investment goods prices will lead to the errors in the estimation of investment goods output, capital goods input and total factor productivity.

Jorgenson and Griliches claimed that with appropriate input measurement, the allocation of the contribution of the factors to the economic growth could properly be done. For example, the advances in education could not increase the national product without raising the marginal product of the factors, so the contribution of knowledge would disappear as a source of growth. Denison (1966) questioned the reasons for the methodology Jorgenson and Griliches applied in the measurement of capital. He criticized the substitution of consumer's durables prices in place of price indexes for producer's durables to deflate producers' durables expenditures.

Jorgenson and Griliches (1966) believed a change in inventory was due to the change in the implicit deflator. There is year-to-year fluctuations in the inventory level so the deflator for the inventory change may vary. But the appropriate reason for a change in the deflator of inventory is the composition of the inventory as one year the change in inventories may consist mainly of wheat and the next year it may consist half-built airplanes (Denison, 1966)[14].

Question of embodiment of technical progress

The question of the embodiment of technical progress into the machinery also posed a debate among the scholars. Abramovitz (1962), Solow and Denison (1964) got different estimates on economic growth of alternative investment rates as they gave different degrees of importance to the importance of embodiment of new knowledge in capital goods. Denison (1964) claimed that the question of embodiment was of little importance for policy formation. He even calculated the accounts of embodiment effects with different weights given to the process of embodiment and found that the difference in the contribution was negligible. The effects of embodiment do not hold good in countries where capital goods have a longer life and where the tendencies towards convergence of rates of return are extremely week because of lack of competition.[15]

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[14] Denison (1966: 78).

[15] Denison (1964)

The technological progress embodied in the capital referred to the changes in the quality of capital goods and was judged by the ability to contribute to production and production cost at a common date. Abramovitz (1962) stated that the factual gap like reduction in cost due to managerial and organisational improvements, changes in equipment design, hours of work, education, capital input led to difference in the results. But both the embodied and disembodied technical change could not be recognized by these facts.[16]The importance of embodiment, denied by Denison was found to be inappropriate as in measuring the potential economic growth it was useful to calculate the investment required for the target (Jorgenson, 1966).

Institutions not recognized

Nelson explained that the underlying theoretical model for most of the productivity growth studies was superficial and to some extent even misleading regarding determinants of productivity growth, process of new technology and influence of macroeconomic institutions. The presumptions of the neoclassical growth and production function were very stylized, and they did not even acknowledge the Schumpeterian impossibility of co-existence between technological advancement and competitive equilibrium. The sources of growth were treated as independent and additive, and no institutional changes had been recognized in this model.[17]

Much of the empirical works on productivity concentrated on the specification of inputs. And in this process the size of the residual (which Solow has given a particular interpretation) was squeezed and the importance of association of technological advancement with the residual was reduced. So this calls for a reconceptualization of neoclassical growth process. Considering technological knowledge as public good and growth is an equilibrium process makes the neoclassical theory inconsistent with the growing capitalistic structure of institutions. Despite all the efforts to explain the 'residual' (the measure of our ignorance), the mystery is still to be solved. The heterodox thinkers have chosen to look the behavior of the firm, managerial quality,labour management, and skill of workers as the factors behind the productivity

[16]Abramovitz (1962: 780)

[17] Nelson (1981)

difference. Macroeconomic institutions neglected by the neoclassical theorists are a significant contributor to growth.[18]

Factor substitutions

Shmookler (1952), Schultz (1953), Fabricant (1954), Kendrick (1956) and Abramovitz (1956) are pioneers in studies of American output growth. None of them has attempted to divide the credit between Technological advancement, changing workforce, investment in human capital, relocation of resources and economies of scale. Probably they have recognised the complementarities among these factors.

The growth of one input augments the others' marginal productivities. So here the complementarity becomes significant not the substitutability. But Solow (1957) has gone beyond to attribute growth to various sources consistent with his neoclassical theoretical model. The growth accounting method identifies the sources of growth and their independent contribution. Nelson (1981) has considered all inputs are needed and it makes no sense to attribute credits of output growth to the various independent yet complementary inputs.[19] The strong connections between most sources of growth are to be recommended.

Evolutionary theory

The heterodox features of growth though they are treated as fundamental, could not find their place in neoclassical theory. So the neoclassical growth theory, though surrounded by so much of shortcomings, is ‘impossible' to replace. The two authoritative assumptions of profit maximisation of firm and movement of growth in equilibrium certainly raised questions of many evolutionary economic thinkers. The important phenomena like diffusion, Schumpeterian competition, resources allocation get diluted by such presumptions. So the evolutionary models were pronounced in which uncertainty and cost of technology were taken into account. Though these models are very primitive in nature, they are a great leap forward deviating from neoclassical growth theories.[20]

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[18] Nelson (1981)

[19] Nelson (1981: 1051)

[20] Ibid, 1062.

The above discussion raises theoretical issues with the neoclassical method of measurement of productivity. Nelson (1981) has even become very critical of the theory not being supported by the empirical research and terms this situation as ‘stage of diminishing returns’ in neoclassical paradigm.[21]Despite the conceptual problem, various studies have resorted to empirical estimation of Total Factor Productivity Growth. Apart from these theoretical controversies, some methodological issues have also been raised. Double deflation described in the next section is a long-standing issue in the measurement of productivity.

2.4 Double deflation

The natural desire to measure the true productivity gain as an indicator of economic progress calls for the identification of the reliable real value added. The incorporation of the intermediate inputs into the productivity measurement has been the prime motive for Double deflation. Double deflation is a procedure to obtain a measure of deflated value added that is based on a price index that combines the price index of gross output with the price index of intermediate inputs. But to make double deflation empirically feasible a narrow concept is used to obtain value added. In the double-deflation, the output is deflated by one and another deflator is used to deflate the value of intermediate inputs. Double deflation method deflates outputs and inputs separately, each with their price index. This section argues whether to use double deflation or single deflation to get the real value added for estimating TFP growth through the conventional approaches.

The double deflation method has been sharply criticised as it provides a measure of real value added of industries only under extremely restrictive assumptions. This method can yield negative figures for the real value added when there are substantial changes in relative prices, or there are extensive changes in input proportions due to factor substitution or technical change. The estimation of real value added using double deflation method does not ensure a positive

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[21] Ibid, 1030

value added. The fact that negative value added is very abstract and difficult to interpret; its use in productivity measurement does not hold arguments (OECD Manual, 2001: 34).[22]

The growth in the real value added is susceptible to the share of value added in the gross output. If the share of value added in gross output is small, then it may result in large variations in growth of deflated value added even though the small changes occur in the growth of gross output and intermediate inputs.

The concept of double deflation uses the Laspeyres quantity index or Paasche price index. This method is, in fact, feasible only for constant price estimates which are additive in nature.Furthermore, the use of the double deflation could hide some important process behind economic growth such as technical progress efficiency, rent spillovers and all those elements that may concern disembodied technological change.

Balakrishnan and Pushpangadan (1994) (B-P henceforth) tried to open up the source of bias in estimates of productivity due to the assumption of constancy of the relative price of material inputs. B-P made a critique of the earlier studies of Ahluwalia (1985, 1991) and Goldar (1986) and used the -Tornqvist approximation for the calculation of TFP growth. But they had applied double-deflation method instead of single deflation used in earlier studies to arrive at the real value added. B-P argued that value-added by single deflation as a measure would be valid only if the relative price of materials on the price of output is stable. But if the relative prices change then it might inversely affect the productivity estimation. So B-P were in favour of double-deflation method to keep the problem of relative price change out of content.

Responding to the question whether to use double deflated value added in the calculation of TFP growth or not, Ahluwalia (1994) accepted double deflation method to be better than the single deflation method when value added are adjusted for price changes. But she doubted the feasibility of the method in Indian context by non-availability of reliable data. She also criticised the fixed weights used in the study by B-P (1994) taken from the input-output table of 1973-74

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[22] The System of National Accounts 93 notes that negative real value added can occur when relative prices change: "a process of production which is efficient at one set of prices may not be very efficient at another set of relative prices. If the other set of prices is very different, the inefficiency of the process may reveal itself in a very conspicuous form, namely negative value added." (OECD manual on Productivity Measurement, 2001: 34)

which did not capture the structural change took place during 1970's and 1980's. Commenting on the study of B-P (1994), Dholakia and Dholakia (1994) had raised doubts about the reliability of methodology adopted by them. They found that the primary problem in estimating real value added by double deflation method was the estimation of an appropriate price index for material inputs. The authors had also shown that the growth of real value added by using double deflation method was highly sensitive to the set of weights used in the input price index. Also, they had provided insight into the nature of base year biasedness in the case of double deflation method. Entering into the debate of double-deflation Sastry (1995) discarded Ahluwalia's comment of unavailability of reliable data and also suggested a chain index to incorporate structural changes.The empirical results found from the study completely replicated the results that were found by Ahluwalia (1991) and B-P (1994). But the author made a note that the double deflation index suffered a smaller bias than the single deflation index and was greatly influenced by the trends of relative prices.

It is thus clear that the calculation of double deflated value added may not be a good measure compared to the single-deflated real value added. Firstly, the growth of real value added by using the double-deflation method is highly sensitive to the set of weights used to derive the input-price index. So the double-deflation method would provide different results for different base years whereas the single deflation method gives a unique outcome. Thus the problem of index number is avoided in the single-deflation method. Secondly, the double-deflation method has been criticised as it provides a measure of the real value added of industries only under extremely restrictive assumptions i.e. this method is applicable only for constant price estimates which are additive in nature such as those calculated using a fixed-base price index. Finally and most importantly, the double-deflation method does not guarantee a positive real value added and real value added is not economically meaningful.

2.5 Estimation of total factor productivity growth

Here estimation of TFP growth is carried out by using Kendrick index, Solow index and Translog index (both by single deflation and double deflation). Equation 1, 8 and 9 are used to get the estimates. Input-Output Transaction Table and Socio-Economic Accounts published by WIOD are used to collect the necessary data for the estimation (details of the data and variable used is presented in the appendix to the chapter). The estimates are carried out for the period 1995 to 2009. From the estimates, it can be observed that all the indices estimated confirmed TFP growth when the single deflatedreal value added is applied. But the growth estimates turn negative when the double-deflation method is used.

The estimated Kendrick index confirms TFP growth in all broad sectors when single deflation method is used. But the results from double deflated method suggests a fall in TFP for Agriculture and allied activities (-0.81) and Mining and Quarrying (-8.22). TFP growth for manufacturing sector is estimated to be 0.02 and 0.01, respectively when single deflated and double deflated real value added is used. The single deflated TFP growth for services is 0.06 while it is estimated to be 0.56 using double deflated real value added. For Electricity, Gas and Water Supply and Construction sector the double deflated TFP growth is found to be higher than that of the single deflated TFP growth.

The Solow index also shows the same trend when different value added (single deflated or double deflated) is used. The estimates show single deflated TFP growth of Agriculture and allied activities was 0.11, but the double deflated TFP growth for the sector is a negative 0.80. For manufacturing the estimates of TFP growth by Solow index are positive. But the single deflated TFP growth (0.07) is higher than the double deflated TFP growth (0.05). Service sector TFP growth shows higher estimates when double-deflation method is used (0.69) than that of when single deflation method is used (0.13). Construction and Electricity, Gas and Water supply sector estimates also confirm the same results.

TFP growth estimated through Translog index for agriculture, and allied activities is0.16 when the single deflation method is used, but in case of double deflation, the TFP growth is -0.22. Manufacturing sector TFP has grown during the period at the rate of 0.15 in single deflation, but in the case of double-deflation, the growth rate islittle slower at 0.13. For other sectors also the TFP growth using single deflation is highly significant and positive, but the double-deflation method indicates a negative growth of TFP.

Table 2.1: Total Factor Productivity Growth (in percentage) (1995 to 2009)

	Kendrick Index		**Solow Index**		**Tornqvist Index**	
	SD	**DD**	**SD**	**DD**	**SD**	**DD**
Agriculture and Allied Activities	**0.05**	**-0.81**	**0.11**	**-0.80**	**0.16**	**-0.22**
Mining and Quarrying	**0.07**	**-8.22**	**0.14**	**-8.43**	**0.21**	**-0.25**
Food Processing	0.05	-1.08	0.11	-1.18	0.16	-0.27
Textiles& Textile Products	-0.01	-0.25	0.03	-0.26	0.10	-0.27
Leather and Footwear	-0.01	-1.31	0.05	-1.53	0.12	-0.28
Wood & Products of Wood	-0.02	0.11	0.07	0.20	0.11	-0.14
Paper, Printing & Publishing	0.02	0.14	0.05	0.18	0.11	-0.15
Rubber, plastic andpetroleum	0.05	0.16	0.09	0.19	0.21	-0.13
Chemical Products	0.04	0.22	0.08	0.26	0.16	-0.14
Non-Metallic Mineral	0.03	0.21	0.08	0.27	0.15	-0.15
Basic & Non-Ferrous Metal	0.03	0.28	0.09	0.33	0.17	-0.17
Electrical & Optical Equipment	0.05	0.33	0.09	0.40	0.15	-0.18
Transport Equipment	-0.01	0.20	0.00	0.18	0.14	-0.19
Manufacturing Nec., Recycling	0.02	0.33	0.09	0.44	0.16	-0.21
Manufacturing	**0.02**	**0.01**	**0.07**	**0.05**	**0.15**	**0.13**
Electricity, Gas and Water Supply	**0.04**	**0.21**	**0.08**	**0.28**	**0.13**	**-0.18**
Construction	**0.06**	**0.30**	**0.16**	**0.43**	**0.23**	**-0.20**
Services	**0.06**	**0.56**	**0.13**	**0.69**	**0.18**	**-0.21**

Source: Estimated from data collected from NIOT and Socio-Economic Accounts published by WIOD.
Variables Used: Gross Value Added, Total Person Engaged, Fixed Capital Stock, Labour Compensation and Capital Compensation.
Deflator Used: GDP deflator, 2004-05
Note:

1. SD stand for single deflation and that of DD stands for Double deflation.

2. The values are the average annual growth rate in TFP

3. Methodology for Calculating Double Deflated Real Value Added is explained in Appendix 2.1.3

4. The period in the calculation is from 1995 to 2009 because the data on labour compensation and capital compensation is available for the period.

In the case of manufacturing sectors each of the three indices using double deflation give negative TFP growth for Food Processing, Textile and Leather Product while the double deflated TFP growth for other manufacturing sectors are negative only when calculated through Translog index. Food processing, rubber, plastic and petroleum product, chemical product, non-metallic mineral products, basic metal products, electrical products and manufacturing n.e.c., and recycling are some manufacturing sector which has achieved high TFP growth as estimated by these indices using single deflation. The labour-intensive manufacturing sectors like Textile products, Leather products, Wood products, Paper products have very slow TFP growth.

The estimates of TFP growth from the indices give a different result. There is also a significant difference between the estimates of TFP growth calculated by Translog index, Solow index and Kendrick Index. It can also be seen that the double deflated Solow index and Kendrick index give higher estimates of TFP growth than that of by the single deflated indices except for the Food Processing, Textile, and Leather manufacturing.

2.6 Estimation of total factor productivity growth for registered manufacturing

For the estimation of TFP growth for the registered manufacturing, Annual Survey of Industries is used as data source. The estimates are carried out for two periods i.e. from 1980-81 to 2012-13 and 1995 to 2011. For the first period of study only single deflated TFP growth is estimated but for the second period of study, both the single deflation and double deflation method are used. The period 1980-81 to 2012-13 is studied to look for a longer period. The second period of study is taken to facilitate comparisons between the results found in the previous section. All the three indices are estimated both by single deflation and double deflation method.

Table 2.2 presents estimates of Total Factor Productivity Growth (TFPG) is being estimated for the registered manufacturing sectors for the period 1980-81 to 2012-13. The estimation used single deflated gross value added as a proxy for output. During the period 1980-81 to 2012-13, the TFP growth for the registered manufacturing was found to be 0.075 as estimated by Translog index, 0.014 as estimated by Solow index and 0.003 as estimated by Kendrick index. These indices are in similar line with the literature (Goldar, 2004; Trivedi and et al. 2000, 2011) but the figures estimated are not matching due to the differences in the period, variables used and deflators used.

The estimation shows very high TFP growth if estimated by Translog index than that of by Solow index. Rubber, plastic, and petroleum product registered a TFP growth of 0.098, the highest growth among the different manufacturing sectors estimated by Translog index. For the same sector, the TFP growth estimated by Solow index was 0.007, and that of by Kendrick index is 0.035.

Table 2.2: Total Factor Productivity Growth for registered manufacturing (in percent) (1980-81 to 2012-13)

	Kendrick's Index	Solow's Index	Translog Index
Food processing	0.023	0.011	0.073
Textile products	0.020	-0.022	0.057
Leather and Footwear	0.041	-0.020	0.073
Wood products	0.050	0.069	0.055
Paper product	0.022	-0.018	0.053
Rubber, plastic and petroleum	0.035	0.007	0.098
Chemical products	0.024	0.018	0.081
Non-metallic mineral products	0.002	0.013	0.085
Basic & non-ferrous metal	0.007	-0.006	0.064
Electrical &optical equipment	0.016	0.015	0.086
Transport equipment	0.022	0.027	0.089
Manufacturing Nec., recycling	0.103	-0.222	0.092
Manufacturing	**0.003**	**0.014**	**0.075**

Source: Data collected from Annual Survey of Industries (ASI)

Variable Used: Gross Value Added, Total Person Engaged, Fixed Capital, Labour Compensation, Profit, and Depreciation.

Deflator Used: GDP deflator at 2004-05 prices.

Note: The values are the average annual growth rate in TFP.

Kendrick index shows highest TFP growth is achieved for manufacturing nec., and recycling sector (0.103). High TFP growth is estimated in the sectors like food processing (0.023), leather products (0.041), wood products (0.050), rubber, plastic and petroleum products (0.035), paper products (0.022), chemical products (0.024) and transport equipment (0.022). Other manufacturing sectors also have achieved positive TFP growth.

The Solow index for TFP growth estimated to be lower than the Translog index. The estimated Solow index for the wood product was 0.069, and it was highest among the other sectors. High TFP growth was recorded in the sectors like chemical product (0.018), electrical & optical Products (0.015), transport equipment (0.027). Textile product, leather product, paper product, basic &non-ferrous metal product and manufacturing nec. andrecycling registered negative TFP growths as estimated by the Solow index in contrast to Kendrick index and Translog index.

Among the high TFP growth sectors as estimated by Translog index were Manufacturing n.e.c., and recycling (0.092), electrical and optical equipment (0.086), transport equipment (0.089), chemical products (0.081) and non-metallic mineral products (0.085). In other manufacturing sectors, the TFP growth was rather slow during the study period from 1980-81 to 2012-13.

Table 2.3: Total Factor Productivity Growth for Registered Manufacturing (in Percent) (1995-2011)

	Kendrick Index		Solow Index		Translog Index	
	SD	DD	SD	DD	SD	DD
Food Processing	0.004	0.036	-0.011	0.027	0.064	0.081
Textiles& Textile Products	0.035	0.124	-0.039	0.081	0.059	0.151
Leather and Footwear	0.022	0.132	0.019	0.143	0.080	0.155
Wood & Products of Wood	0.073	0.439	0.124	0.491	0.053	0.067
Paper, Printing & Publishing	0.012	0.047	-0.047	-0.007	0.048	0.081
Rubber, Plastic & Petroleum	0.056	-0.010	-0.007	-0.002	0.055	-0.007
Chemical Products	0.034	0.068	0.012	0.048	0.072	0.092
Non-Metallic Mineral	-0.003	0.088	0.015	0.085	0.086	0.142
Basic & Non-Ferrous metal	0.015	0.028	-0.024	-0.009	0.080	0.086
Electrical & Optical Equipment	0.014	0.104	0.008	0.100	0.073	0.151
Transport Equipment	0.001	0.080	0.002	0.089	0.087	0.146
Manufacturing, Nec, Recycling	0.122	0.191	-0.483	-0.476	0.084	0.118
Manufacturing	**0.001**	**0.043**	**0.012**	**0.059**	**0.077**	**0.114**

Source: Data collected from Annual Survey of Industries (ASI)

Variables Used: Gross Value Added, Gross Output, Total Input, Total Person Engaged, Fixed capital, Labour Compensation, Profit and Depretiation.

Deflator Used: GDP deflator at 2004-05 prices.

Note:

1. Values are the Average Annual Growth Rate in TFP.

2. Methodology for Calculating Double Deflated Real Value Added is explained in Appendix A 2.1.3

Table 2.3 presents estimates of TFP growth is estimated for the different registered manufacturing sectors by Kendrick index, Solow index and Translog index (both using both single deflation and double deflation) for the period 1995 to 2011. During the period 1995 to

2011, the TFP growth (single deflation) for the registered manufacturing was found to be 0.077 as estimated by Translog index and 0.012 as estimated by Solow index but the Kendrick index shows a negligible TFP growth. The TFP growth using double deflation for registered manufacturing was 0.114 as estimated by Translog index and 0.059 as estimated by Solow index and 0.043 as estimated by Kendrick index. The difference in the TFP growth index by single deflation and double-deflation method is in contrast to the literature. For the Indian registered manufacturing, the Double deflated TFP indices are found to be less than the single deflated TFP growth indices.[23]The double deflation method used in this study used different input-output tables for the respective years to calculate the weights for the intermediate input index unlike a specific input-output table used in the other studies. The study also finds that the input structure of the different sectors is changing and affected the productivity trends (see, Chapter 5). So the results might not follow those of earlier studies which also differ from the period covered, use of variables and deflators.

The TFP growth estimated through single deflation registered in the Transport Equipment was 0.087, the highest growth among the different sectors. For the same sector the TFP growth estimated was 0.002 by Solow index and 0.001 by Kendrick index. Among the high TFP growth sectors as estimated by translog index were leather products (0.080), non-metallic mineral products (0.086), manufacturing n.e.c., and recycling (0.084) and basic metal product (0.080). In other manufacturing sectors, the TFP growth was rather slow during the study period from 1995 to 2011.

TFP growth estimates through single deflated Kendrick index shows the highest growth in manufacturing nec., and recycling (0.122). High TFP growth is estimated for textile products (0.035), leather products (0.022), wood products (0.073), rubber, plastic and petroleum product (0.056) and chemical product (0.034). Non-metallic mineral product recorded a negative TFP growth (-0.003) for the study period.

The estimated single deflated Solow index for the wood Product sector was 0.124, and it was highest among the other sectors. High TFP growth was recorded in the sectors like leather

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[23]Balakrishnan and Pushpangadan (1994, 1998, 2002), Balakrishnan (2004)

products (0.019), chemical Product (0.012), non-metallic mineral product (0.015). Basic and non-ferrous metal, rubber, plastic and petroleum product and paper products, food products, textile products, and manufacturing nec., and recycling registered a negative TFP growth as estimated by the Solow index in contrast to the Translog index.

The TFP growth in the leather products was registered at 0.155, the highest growth among the different sectors as estimated by double deflated translog index. For the same sector, the TFP growth estimated by Solow index was 0.143, and that of by Kendrick index was 0.132. Among the high TFP growth sectors as estimated by translog index (double deflated) were electrical and optical equipment (0.151), transport equipment (0.146), textile product (0.151), non-metallic mineral products (0.142). In other manufacturing sectors, the TFP growth was rather low during the study period from 1995 to 2011.

Kendrick index using double deflated real value added shows highest TFP growth in Wood product (0.439). High TFP growth is registered in Textile products (0.124), Leather products (0.132), Electrical and optical products (0.104) and manufacturing nec., and recycling (0.191). This estimate shows a negative TFP growth for the Rubber, plastic and petroleum product (-0.010). Remaining manufacturing sectors achieved a rather slow TFP growth.

The estimated Solow index (Double deflated) for the Wood product was 0.491, and it was highest among the other sectors. High TFP growth was recorded in the sectors like electrical &optical Products (0.100), leather product (0.143), non-metallic mineral (0.085), transport equipment (0.089) and textile product (0.081). Paper product; rubber, plastic, and petroleum product registered a negative TFP growth as estimated by the Solow index.

A comparison of Table 2.1 and Table 2.3 explains the dynamics of the manufacturing sector. Table 2.1 represents overall manufacturing which includes both organised and unorganised sectors while Table 2.3 represents only registered manufacturing sectors. The TFP growth estimated using single deflated real value added in case of Kendrick index, Solow index and Translog index shows higher growth in case of overall manufacturing sectors than the registered manufacturing. The double deflated TFP growth for overall Food Processing, Textile and Textile product, Leather and Footwear shows negative growth whereas their registered counterparts' shows positive TFP growth. The results show the unorganised manufacturing of these sectors has performed poorly during the period of study. These results are contradicting in nature as the single deflated TFP growth indices hint good performance of unorganised sector while the double deflated TFP growth concludes poor performance of the unorganised sector. For the Indian registered manufacturing, the Double deflated TFP indices are found to be less than the single deflated TFP growth indices.[24] The double deflation method used in this study used different input-output tables for the respective years to calculate the weights for the intermediate input index unlike a specific input-output table used in the other studies. The study also finds that the input structure of the different sectors is changing and affected the productivity trends (see, Chapter 5). So the results might not follow the same results as found in earlier studies which also differs from the period covered, use of variables and deflators.

2.7 Summary

The above analysis confirms growth in Total Factor Productivity for the study period of 1995 to 2011. The results do differ according to the index used and also according to the use of single-deflated value added, and double-deflated value added. It can also be seen that the double deflated Kendrick index and Solow index give higher estimates of TFP growth than that of given by the single deflated Kendrick index and Solow index except for the Food Processing, Textile, and Leather manufacturing.

The TFP for the registered manufacturing is positive. During the study period, the registered capital-intensive manufacturing sectors achieved high TFP growth. The registered labour-intensive manufacturing sector achieved a low growth in TFP but the labour-intensive manufacturing (both organised and unorganised added together) reflected a much higher TFP growth in case of single deflation while the tendency was the opposite in case of the double deflation. For the Indian registered manufacturing, the Double deflated TFP indices are found to be less than the single deflated TFP growth indices. The double deflation method used in this study used different input-output tables for the respective years to calculate the weights for the intermediate input index unlike a specific input-output table used in the other studies. The study also finds that the input structure of the different sectors is changing and affected the

[24]Balakrishnan and Pushpangadan (1994, 1998, 2002), Balakrishnan (2004)

productivity trends (see, Chapter 5). So the results might not follow the same pattern as found in earlier studies which also differ from the period covered, use of variables and deflators.

TFP growth depends on the factor shares and the rates of factor augmentation. A change in the factor shares can lead to a change in TFP growth even when the underlying rates of technical progress are unchanged. From the calculation, it can be seen that the share of labour and capital in Gross Value Added is changing over the period. The share of labour has a declining tendency, and the opposite is for the share of capital. Had these shares remained constant for the period, it would have given a correct estimate of technical progress.

Growth accounting is undertaken without ascertaining the form of the production function underlying the data. The Kendrick index follows a linear production function. Hence it assumes an infinite elasticity of substitution. It also does not allow for diminishing marginal productivity to factors. The Solow index is based on the Cobb-Douglas production function with constant returns to scale and with Hicks neutrality. So when the C-D production function is estimated, it does not satisfy any of the assumptions (see Chap 3). So the Solow index calculated blindly following the C-D production function does not give any consistent result. The Translog index is derived from a Translog production function under the assumption of competitive equilibrium. The index is more popular from the Solow index and Kendrick index because of the fact that the index restrains itself from the restrictive assumption of unitary or infinite elasticity of substitution. The Translog index does not demand Hicks-Neutrality. The shift in the production function can be estimated even if there is non-neutral technological change. This index also shows promises for non-homogeneous production function and also for non-constant returns to scale. So the index can be useful under various production structures.

To obtain unbiased estimates of TFP growth using Growth Accounting Approach, the assumptions of constant returns to scale, perfect competition, and full capacity utilisation is necessary. If these assumptions are violated, the TFP growth estimates would be biased. The problem is aggravated when there is a change in the policy environment. This is because the factors affecting TFP growth, could also influence the degree of monopoly based on cost and price, and returns to scale of production (Srivastava and Sengupta, 2000). The authors find that these assumptions do not hold in the Indian case. Thus the traditional estimates of TFP growth are pro-cyclical.

Growth accounting measures do not recognise the growth of human capital, economies of scale, organisational improvement.[25] A faster capital accumulation means a faster incorporation of advance of knowledge. Investment decisions of firms are guided by expected profit. So the changing profitability of production is a better guide for growth planning and policy making. TFP growth could not help in this regard.The estimated figure did not give any evidence of changes in the human capital, economies of scale and managerial improvement. These factors have significant influence on the technical progress. The process of embodiment is apparently ignored. There is no division in the labour compensation according to the quality of labour (i.e. no separate labour index composite of educational attainment). In the studies with productivity growth, this aspect is neglected which means the studies have taken technical progress as exogenous.

The methodological and technical criticism of the growth accounting approach leads to the use of more sophisticated econometric tools to estimate Total Factor Productivity Growth. So the researchers opt for estimating TFP growth from the estimation of the underlying production function. The next chapter deals with Production Function Estimation.

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[25]Balakrishnan (2010: Chap. 1).

Appendix

A 2.1 Database, period and methodology

Annual Survey of Industries and National Input-output table by WIOD are the datasets for the study. The period of the study was chosen on the basis of data availability. The period of study is restricted to 1995 to 2011.

A2.1.1 Annual Survey of Industries (ASI)

Annual Survey of Industries (ASI) is the prime source of data on organised manufacturing in India. It is published every year by Central Statistics Office (CSO) of Ministry of Statistics and Programme Implementation (MOSPI). ASI covers the manufacturing sectors registered under the 1948 Industry Act.

ASI collects data on different variables on Output, Factor Input, Distribution and Capital Formation. In this study Gross Value Added, Gross Output, Total input, Total Person Engaged, Fixed Capital, Labour Compensation, Profit, and Depreciation (Detailed definition of the variables is given in Introduction section 1.4.)

A 2.1.2 World Input-Output Database (WIOD)

The World Input-Output Database (WIOD) gives the information regarding increasingly fragmented production process for forty countries worldwide and a model for rest of World, covering a period from 1995 to 2011. The WIOD also gives data on labour and capital inputs. Besides this, the database is also a great source of energy consumption, environmental indicators, and socio-economic variables. WIOD has two segments of database which include World Input-Output Table (WIOTs) and Socio-Economic Accounts. The WIOTs are the source of input-output transaction table. Socio-Economic Accounts gives the data on Labour Compensation, Capital Compensation, Total Person Engaged and Real Fixed Capital.

The World Input-Output Tables (WIOTs) have been constructed in an explicit conceptual framework based on the system of national accounts. They are based on officially published I-O tables merged with national accounts data and international trade statistics. The WIOTs have an industry by industry format as many applications require such matrix reflecting the economic linkages across industries. They provide details for 35 industries mostly at two digits International Standard Industrial Classification (ISIC). These include agriculture, construction, utilities, 14 manufacturing industries and 17 services.

The WIOTs have the distinction from these databases:-

1. These are specifically designed to trace developments over time through benchmarking to time series output, value added, trade and consumption from NAS. But the others are constructed only for a benchmark year.
2. WIOTs are based on official and publicly available data from statistical agencies to ensure quality. The coverage of WIOTs is 40 countries and a ROW region. The tradeoff between coverage and quality is maintained.
3. WIOTs have been constructed by sets of national supply and use tables that are the core statistical sources from which statistical institutes also derive national I-O tables.
4. Apart from WIOTs, WIOD also provides data on Socio-Economic accounts and also environment issues with the similar industry classification that further can be used.

Construction Of WIOTs

1. Harmonisation of national Supply and Use Tables data:-

   A supply table is of the product-by-industry type and indicates for each product the values of its deliveries by domestic industry or imports. A Use table shows the value of purchases of each product by each of its destinations. The SUTs can be combined with trade statistics that are product based and employment statistics that are industry based.

   The products are clubbed into 35 industries and 59 product groups. This level of classification reflects the lowest common denominator across countries. So construction of WIOTs involves aggregation of more detailed source data and sometimes disaggregation based on additional data from detailed production surveys.
2. Time-Series of National SUTs:-

   National tables are only available for particular years that are unevenly spread across countries and time. Again the NAS has regularly been revised, but that is not the case with SUTs. To deal with both these issues, a procedural imputation was applied to SUTs coefficient. This exercise gives most of the exact matches of revised NAS data. The unknown product shares are imputed using a constrained optimisation method related to the bi-proportional (RAS) updating method. The tables also satisfy the important identity in systems of national accounts i.e. total value added (incomes for labour and capital) will be equal to the sum of final domestic use expenditures and the net trade balance.

3. Disaggregation of Imports:-
   Most of the researchers rely on the import proportionality assumption i.e. the product is used equally in all use categories in the share as import share economy-wide. But WIOTs to improve upon this assumption derive the import share for three end-use categories from bilateral trade statistics. The detailed trade statistics of 6-digit product level of HS are used to refine the imported goods into broad economic categories. BEC allocates the imported goods to intermediate input use, final consumption use or investment use. Then within each segment, the proportionality assumption is used to do the allocation.
4. Supplementary data on labour and capital:-
   WIOD also provides data on the quantity and prices of factor inputs, including data on wages by educational level. This comes under a separate table called 'Socio-Economic Accounts'.

A 2.1.3 Method of estimation of double deflated real value added

The first step in the calculation of real value added by using double-deflation method is to calculate a separate price index for the material inputs. The GDP deflator with the base year 2004-05 has been used to deflate the gross output. To get the value added, intermediate input has to be subtracted from the gross output. For deflating the intermediate input, a separate weighted price index is to be calculated.

Intermediate input price index for sector 'I'

$$I_i \quad = \quad \frac{w_{i1}D_1 + w_{i2}D_2 + \ \dots\dots\dots\dots.. + w_{in}D_n}{w_{i1} + w_{i2} + \cdots \dots\dots\dots. + w_{in}}$$

Here, w_{ij} = weight of jth sector commodity in the total intermediate input of ith sector.
Dj = GDP deflator for jth sector at 2004-05prices.

w_{ij}'sare calculated from the input-output table. The column in I-O intermediate consumption matrix represents the inputs used in the sector. The weight is calculated by dividing the value of inputs from j^{th} sector for i^{th} sector to total intermediate inputs of i^{th} sector. This kind of set of weights for each sector can be calculated from I-O table.

The D_j's are the GDP deflator at 2004-05 prices calculated from NAS data. The composite index for the intermediate input price is calculated by the above formula. This will give the separate price index for the input material used.

So the real value added by double deflation method = real gross output – real intermediate material inputs.

Conventional Approach to Measurement of Productivity- II (Production Function Approach)

3.1 Introduction

The previous chapter has highlighted the theoretical and methodological controversies in the conventional approach to measurement of productivity, in particular to growth accounting. The empirical inconsistency of the Growth Accounting Approach left the researchers using neoclassical theory with no choice but to resort to the direct estimation of production function to evaluate technical progress. Our empirical estimates of Chapter 2 differ according to the index of Total Factor Productivity Growth and the type of deflator applied to value added. This chapter will discuss the Production Function Approach as an improvement over the Growth Accounting Approach. The estimation of production function has one advantage over growth accounting is that it is not necessary to assume competitive equilibrium to derive an estimate of productivity growth. The efficiency parameter, scale parameter and the extent of factor substitution can be obtained directly from the estimation. This is not to deny that the production function approach does also have the problems associated with the neoclassical theory (See Chap 2 Section 2.3). The present chapter is devoted to the estimation of the production function to evaluate Total Factor Productivity Growth and to an examination of problem thereof.

Section 3.2 deals with Production Function Approach. Section 3.3 and 3.4 analyse the estimates of TFP growth based on this approach. Section 3.5 provides a summary of discourse. The data used in the chapter are taken from National Input-Output Table for India and Socio-Economic Accounts published by WIOD and the Annual Survey of Industries for registered manufacturing sector (See the Appendix to Chapter 2).

3.2 Production function approach

Production function entails the mathematical relationship between output and factor inputs. The aggregate production function has been employed in neoclassical economics to explain both income distribution and economic growth. When trying to explain income distribution, the theory runs into circular reasoning because income distribution is used to explain prices and to determine prices one requires income distribution since capital has no natural unit of measurement. Moreover, there are serious issues relating to aggregation when constructing an aggregate production function (Felipe and Fisher, 2003). In strict terms, it is perhaps impossible to separate the contributions to productivity of labour one and capital because the contributions made by improved machinery and better-skilled workers are neither additive nor separable. TFP is "pure technological progress" disembodied from the labour and capital equipment. After all, by being a residual, the higher the number of direct inputs into production, the less the TFP is. Hence, the TFP estimates can change wildly with changes in the specification of the aggregate production function.

3.2.1 Cobb-Douglas production function[1]

The advancement in defining the relationship of physical production and the amount of the labour and capital is dated back to the progressive introduction of Cobb-Douglas production function. This advancement aims at solving the problems such as, to detect the cause of the increase in production; to determine the relative influence upon production of labour as compared with capital and to measure the probable slopes of the curves of incremental product which are imputed to labour and capital. In their seminal paper 'The theory of production (1928)' Cobb and Douglas made an attempt to deal with these questions as a case study of American manufacturing sector for the period 1899-1922. In this task, the first problem that comes their way is the correct measurement of inputs i.e. of capital and labour. In the measurement of capital, it is very much important to calculate the increase in the real capital. So for this, the value of manufacturing buildings and machinery were deflated by the relative cost index. The index itself is defective as it does not allow for the replacement of original capital at a different price level. Also, the index used in the measurement of working force is defective as (I) it does not include clerical employees, (II) it is based on man-years rather than man-hours and (III) it does not take into account the short-term fluctuations in the workforce. So the index could allow any possible changes in the quality of labour. With this defect in the measurement of input indices, the authors have gone forward to define the relationship between the relative indices of production, labour and capital.

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[1]See, Cobb and Douglas (1928).

The authors found the relationship for the US economy as below:[2]

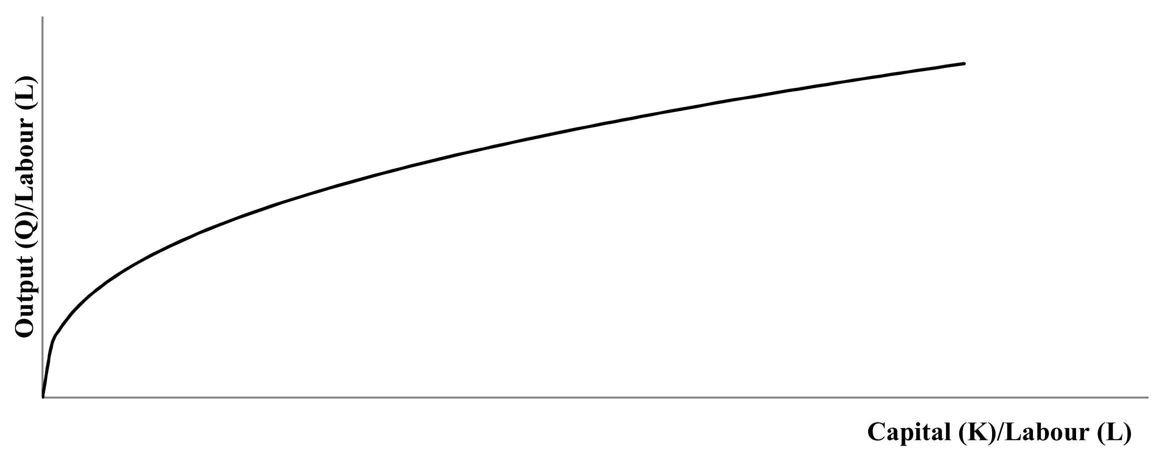
$$Y = 1.01\, L^{3/4} K^{1/4} \quad (1)$$

The estimated production function can be written as in the form

$$V = A\, L^{\alpha} K^{1-\alpha} \quad (2)$$

Equation 2 gives the general form of Cobb-Douglas production function where, V is Output, L and K represent Labour input and Capital input respectively, A refers to the efficiency parameter, and α represents the distribution parameter. This equation only represents the homogenous production function of degree one. This function was first developed upon the assumptions of a first degree homogeneous function of labour, and capital and output would approach zero when either of the two inputs approaches zero.

Fig. 3.1: Cobb-Douglas Production Function (A=1.25, α = 0.4)



[2] Ibid, 151

Fig. 3.2: Isoquant for Cobb-Douglas Production Function
(A= 1.25, α = 0.4, Q= 2)

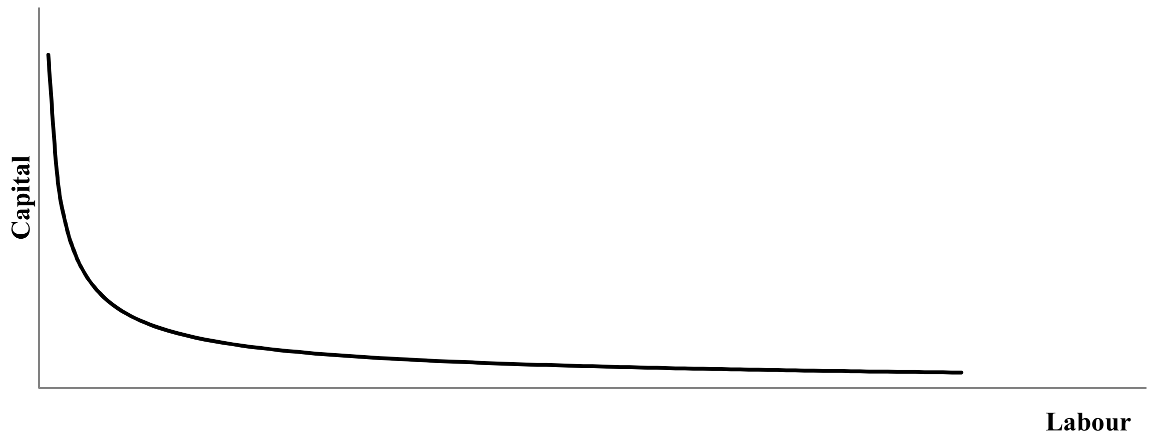


Figure 3.1 and Figure 3.2 give the shape of production function and the corresponding isoquant for the Cobb-Douglas technology with an Arbitrary value of A (1.25) and α = 0.4. The Cobb-Douglas Production function will be a concave production function and the corresponding isoquant will be a convex to origin and asymptotic curve.[3]

A more generalised form of the equation is used in production theory given as below:

$$V = A\,L^{\alpha}K^{\beta} \qquad (3)$$

Equation 3 gives the most common form of Cobb-Douglas production function where, V is Output, L and K represent Labour input and Capital input respectively, A refers to the efficiency parameter, and α and β represent the distribution parameters. This equation represents the homogenous production function of any degree.

Properties of C-D production function[4]

I. The C-D production function is a homogenous production function of degree (α+β)[5].

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[3] A Concave function is the one where every segment of the line joining two points on the curve always lies below the graph. A covex function is one where every segment of the line joining two points on the curve always lies above the graph.

[4] Proofs of the properties are explained in Appendix 3.1.

II. The marginal products of the factor inputs depend on their average products.

III. C-D production function satisfies Euler's theorem. This implies the factor inputs are paid according to their marginal products.

IV. The elasticity of factor substitution for C-D production function is one.[6] The unitary elasticity of substitution implies no change in the factor share in the face of changes in relative factor prices if there is no technological change. Again the feature of unitary elasticity of substitution ensures the existence and stability of equilibrium growth. The unitary elasticity cannot represent technological advancement due to factor substitution.

V. The exponents i.e. α and β represents the output elasticities of labour and capital respectively.

These above equations do not give the estimates of Total Factor Productivity growth as Technology is not a factor of production. So when in equation 3, a term for disembodied technology is introduced; we get a C-D production function of the form as below:

$$V = A_0 e^{\beta_t t} L^{\beta l} K^{\beta k} \quad (4)$$

where V, L, K and t refer to output, labour, capital and time respectively. Technology is assumed to be an exponential function of time ($e^{\beta_t t}$). It is also assumed to be Hicks- neutral.[7] β_l and β_k are the distribution parameters. $A_0 e^{\beta_t t}$ is the efficiency parameter which is a function of time.

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[5] A linear homogenous production function is so simplifying that it can be extended to the general production functions. The linear homogenous production function merits in the analysis of distribution and aggregate production. But on a technical note, the linear homogenous production function fails to represent the total product curve with a point of inflexion.

[6] The elasticity of substitution is a strategic indicator of growth. A high elasticity of substitution usually has a higher output as compared to an industry of a low elasticity. Also in a country like India where both employment generation and output growth is important, high elasticity of substitution solves the problem of factor mobility. Low elasticity of substitution contributes to a rigid production structure. So the economy will not be able to exploit the comparative advantage in trade. The growth rate of capital and labour are usually different, so the bias of the technical change will depend on the elasticity of substitution. So it is important to estimate such crucial parameter empirically.

Further, See, Brown (1966), Diwan and Gujarati (1968), Behrman (1972), Mehta (1980: Chap. 5).

[7] Hicks-neutral technological change is one which does not affect the capital-labour ratio. So the marginal rate of technical substitution between capital and labour is independent of technical change. Hicks-neutral technical progress can also be defined as with any given capital-labour ratio, the marginal and average product of capital and labour increase in the same proportion.

A logarithmic transformation of C-D production function (equation 4) yields a linear equation

$$\log V = a + \beta_l \log L + \beta_k \log K + \beta_t t \quad (5)$$

Taking a first order derivative of equation (5) on 't' we will get

$$\frac{1}{V}\frac{dV}{dt} = \frac{\beta_l}{L}\frac{dL}{dt} + \frac{\beta_k}{K}\frac{dK}{dt} + \beta_t \quad (6)$$

From further transformation of equation 6, we arrive at

$$g(V) = \beta_l g(L) + \beta_k g(K) + \beta_t$$

Here β_l and β_k are the elasticities of output with respect to labour and capital and g(V), g(L) and g(K) are the growth rates of output, labour and capital. The OLS estimation of the specification given in equation (5) yields estimates of β_l, β_k, *and* β_t. While β_t provides a measure of TFP growth, the sum of β_l and β_k is a measure of degree of homogeneity.

As elasticity of substitution is a strategic economic indicator for growth and distribution of income, the estimation of the C-D production function with unitary elasticity of substitution may not carry much value for policy. The C-D production function is very restrictive and can be used as an economic tool in a vast range of applications. But the Constant Elasticity Substitution (CES) production function is used for formal explanation of production technology, and it is also a convenient tool for empirical research. The CES production function is not characterised by the restrictions of C-D production function as it gives a broad range of information regarding different parameters on distribution, returns to scale, efficiency and also elasticity of substitution.

3.2.2 The CES production function

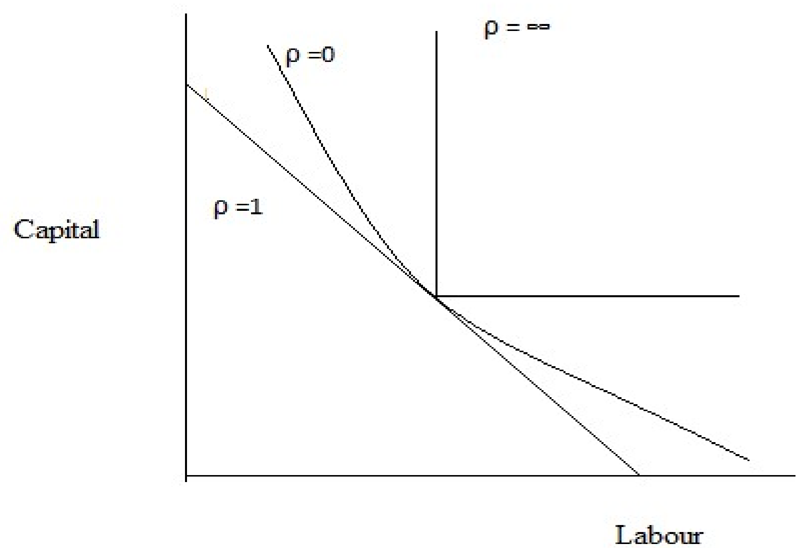
The CES production function allows the elasticity of substitution to take on any value in the range 0 to ∞. The CES production function gives the flexibility to make output growth projection with changing factor proportion at very small as well as large elasticity of substitution. Also, it was found that with restrictive values for the elasticity of substitution, the CES production function approaches C-D production function. So the added explanatory power of the

CES production function is the primary reason for its wide use. The simplest form of the function depicts constant returns to scale, given as below:[8]

$$V = \gamma[\delta K^{-\rho} + (1-\delta)L^{-\rho}]^{\frac{-1}{\rho}} \qquad (7)$$

where V, L, K refer to output, labour, and capital respectively. ‘γ’ refers to the efficiency parameter, δ refers to distribution parameter and ρ refers to the substitution parameter.

Figure 3.3: Isoquants for CES Production Function



In the Figure 3.3, Isoquants for CES production function is depicted for three different values of substitution parameter. If the elasticity of substitution is ∞ then, the isoquant is a linear straight line; If elasticity of substation is 1, then it will give Cobb-Douglas type isoquant; if elasticity of substitution is 0, the isoquant will be L-shaped.

The more general form of the CES production function exhibits all the returns to scale according to the value of ‘μ’ and also represents distribution with sum of distributive parameters not equal to one.

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[8] See Arrow et al. (1961: 230)

$$V = \gamma[\delta K^{-\rho} + \varphi L^{-\rho}]^{\frac{-\mu}{\rho}} \quad (8)$$

where V, L, K refer to output, labour, and capital respectively. γ refers to the efficiency parameter; δ and φ refer to distribution parameter; ρ refers to the substitution parameter, and μ refers to scale parameter.

Properties of CES production function[9]

I. CES production function is a homogenous production function of degree μ, and it exhibits different returns to scale. If the value of 'μ' is greater than one, then it is increasing returns to scale, for μ equal to one it is constant returns to scale and for diminishing returns to scale the value of μ will be less than one.

II. CES production function satisfies Euler's theorem. This theorem implies the factor inputs are paid according to their marginal products.

III. The elasticity of substitution is $\sigma = \frac{1}{1+\rho}$

If the elasticity of substitution is small, then it is difficult to increase the output by increasing only one factor. If the elasticity of substitution is significant, then output growth can be achieved through increasing only one factor. As the growths of factors are not at the same rate, elasticity of substitution affects the growth rate. If the factor proportions do not change due to growth in factors, then growth is independent of elasticity of substitution.[10]

IV. The C-D production function is a limiting case of CES production function i.e. when ρ tends to 0 and σ tends to 1, the CES production function approaches the C-D production function.[11]

The above specifications do not characterise any technical change. So to introduce Hicksian neutral technical change the specification described below is used.[12]

$$V = \gamma_o e^{\alpha t}[\delta K^{-\rho} + (1-\delta)L^{-\rho}]^{\frac{-\mu}{\rho}} u^{e_{it}} \quad (9)$$

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[9] Proofs of the properties are explained in Appendix 3.2.

[10] See Nelson (1965: 326)

[11] See Arrow et al. (1961:231)

[12]See Further Brown and de Cani (1963).

Applying a logarithmic transformation in equation (9)

$$\ln V = \ln \gamma_0 + \alpha t - \frac{\mu}{\rho} \ln[\delta K^{-\rho} + (1-\delta) L^{-\rho}] + u_{it} \quad (10)$$

where V, L, K refer to output, labour, and capital respectively. γ refers to the efficiency parameter; δ and φ refer to distribution parameter; ρ refers to the substitution parameter, and μ refers to scale parameter. If the value of 'μ' is greater than one, then it is increasing returns to scale, for μ equal to one it is constant returns to scale and for diminishing returns to scale the value of μ will be less than one.

Kmenta specification of CES production function (1967)[13]:

The CES production functions discussed in equation (10) are non-linear. So an alternative method is proposed by Kmenta (1967) which is linear and can be estimated by least square technique. The estimation of equation (11) gives the CES specification for the economic sectors. The approximation to CES production function can be written as:

$$\ln V_{it} = \ln \gamma + \mu\delta \ln K_{it} + \mu(1-\delta) \ln L_{it} - \frac{1}{2}\rho\mu\delta(1-\delta)(\ln K_{it} - \ln L_{it})^2 + \alpha t \quad (10)$$

$$\ln V_{it} = \beta_1 + \beta_2 \ln K_{it} + \beta_3 \ln L_{it} + \beta_4 (\ln K_{it} - \ln L_{it})^2 + \alpha t \quad (11)$$

Where$\beta_1 = \ln(\gamma)$, $\beta_2 = \mu\delta, \beta_3 = \mu(1-\delta), \beta_4 = \frac{-1}{2}\rho\mu\delta(1-\delta)$

The estimated parameters of CES production function give an idea about the efficiency parameter, returns to scale parameter, distribution parameter and also the elasticity of substitution parameter. This specification is a development over the Cobb-Douglas production function which is based on a priori assumption like constant returns to scale, unit elasticity of substitution. The CES production function gives the substitution parameter.

The additive and homogenous nature of the CES production function has been very helpful in statistical formulation in the production theory. The constancy of elasticity of substitution is also a departure from the popularly used C-D production function. But Transcendental logarithmic (Translog) production function take a greater leap forward by not

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[13]Kmenta (1967: 180).

employing the above two characteristics of earlier discussed production function. This makes the Translog production function far more applicable in the real situation.

3.2.3 Transcendental logarithmic (Translog) production function

The Translog production functions are quadratic in logarithms of the inputs. The Translog production function is a flexible functional form not much restricted by the a priori assumptions about technology. It does not assume Hicks Neutrality and constant rate of technological change, and also it allowed a variable elasticity of substitution of the inputs.

$$Log(V) = \beta_0 + \beta_l(LogL) + \beta_k(LogK) + \beta_t T + {}^{1}/_{2}\,\beta_{ll}(LogL)^2 + {}^{1}/_{2}\,\beta_{kk}(LogK)^2 + \beta_{lk}(LogL)(LogK) + \beta_{lt}(LogL)T + \beta_{kt}(LogK)T + {}^{1}/_{2}\,\beta_{tt}T^2 \quad (12)$$

Taking the derivative of equation (12) on 't.'

$$\frac{\partial \log V}{\partial t} = \beta_t + \beta_{lt}(\log L) + \beta_{kt}(\log K) + \beta_{tt}\,(T) \quad (13)$$

Where V, L, K and T represent Value added, Labour, Capital and Time. ($\beta_l + \beta_k$) gives the degree of homogeneity and thus returns to scale. The parameters of the equation (13) give different depiction of the technical change. β_t is the rate of autonomous TFP growth; β_{tt} is the rate of change in TFP growth, and β_{lt} *and* β_{kt} define the bias in *TFP growth.* If β_{lt} is positive, and then the share of labour increases and thus is a labour using bias. If both are zero, then TFP growth is Hicks Neutrality type. The quadratic terms i.e. β_{ll}, β_{kk} *and* β_{lk}, give the curvature of the production curve. Equation (13) depicts the rate of technological change.

The elasticity of output with respect to labour (E_l) is given by:

$$E_l = \beta_l + \beta_{ll}(logL) + \beta_{lk}(logK) + \beta_{lt}T \quad (14)$$

But the drawback of translog production function is that it becomes well behaved iff one assumes constant returns to scale and homotheticity. The marginal rate of substitution between capital and labour are constant at constant capital-labour ratios. In such a situation the optimal factor proportions are independent of scale. For a Translog production function to exhibit constant returns to scale, the following conditions are required:

$\beta_{ll} + \beta_{lk} = 0;$

$\beta_{lk} + \beta_{kk} = 0$;

$(\beta_l + \beta_k) = 1$; and $\beta_{lt} + \beta_{kt} = 0$

3.3 Estimation of production function and total factor productivity growth

Here estimation of TFP growth is carried out by using Cobb-Douglas, Constant Elasticity of Substitution and Translog production function specification (both by single deflation and double deflation). Equation 5, 11 and 12 are used to get the estimates. Input-Output Transaction table and Socio-Economic Accounts published by WIOD are used to collect the necessary data for the estimation (details of the data and variable used is presented in the appendix to the chapter 2). The estimation is carried out for the period 1995 to 2009. From the estimates, it can be observed that TFP growth estimates when the single deflated real value added is applied. But the growth estimates are negative when the double-deflation method is used.

Table 3.1 gives the estimation of C-D specification by single deflation and double deflation respectively. The estimates from single deflation method show TFP growth is registered in Services at 0.06% during the period 1995 to 2009. Manufacturing TFP has a negative growth of 0.02%. Agriculture and allied activities have a negative TFP growth. On the other hand the double deflation estimates show TFP growth was negative for all the three sectors. It is important to note that Services have positive significant TFP growth by single deflation method, demonstrate negative TFP growth in case of double deflation method. Agriculture and allied activities in the double-deflation method has a 0.23% fall in the TFP growth, so also the Manufacturing TFP fell by 0.02% in the period 1995 to 2009. (See Table 3.2)

Table 3.1: Estimated Cobb Douglas Production Function for some Sectors (1995-2009)

Model Specification:		$\log V = a + \beta_l \log L + \beta_k \log K + \beta_t t$
Agriculture & allied Activities[14]	S D	$\log V = -22.52 + 0.86 \log L + 1.79 \log K - 0.05t$ $t(\alpha) = -2.27,\ t(\beta_l) = 1.44,\ t(\beta_k) = 7.57,\ t(\beta_t) = -1.97$ Adjusted R-Square = 0.99 , D-W Statistics = 1.09, F Statistics = 642.93
	D D	$\log V = -71.83 + 4.53 \log L + 1.909 \log K - 0.23t$ $t(\alpha) = -0.24,\ t(\beta_l) = 0.26,\ t(\beta_k) = 0.29,\ t(\beta_t) = -0.31$ Adjusted R-Square = -0.28, D-W Statistics = 1.84 , F Statistics = 0.04
Manufacturing	S D	$\log V = -11.69 + 0.58 \log L + 1.28 \log K - 0.02t$ $t(\alpha) = -1.15,\ t(\beta_l) = 0.99,\ t(\beta_k) = 4.62,\ t(\beta_t) = -0.48$ Adjusted R-Square = 1.00 , D-W Statistics = 0.72, F Statistics = 764.81
	D D	$\log V = -11.81 + 0.80 \log L + 1.14 \log K - 0.02t$ $t(\alpha) = -0.65,\ t(\beta_l) = 0.77,\ t(\beta_k) = 2.33,\ t(\beta_t) = -0.227$ Adjusted R-Square = 0.99 , D-W Statistics = 0.87, F Statistics = 391.13
Services	S D	$\log V = 5.34 - 0.66 \log L + 1.09 \log K + 0.06t$ $t(\alpha) = 0.32,\ t(\beta_l) = -0.95,\ t(\beta_k) = 1.66,\ t(\beta_t) = 0.63$ Adjusted R-Square = 1.00, D-W Statistics = 0.55, F Statistics = 1623.96
	D D	$\log V = -354.49 + 15.72 \log L + 12.11 \log K - 1.95t$ $t(\alpha) = -0.60,\ t(\beta_l) = 0.65,\ t(\beta_k) = 0.53,\ t(\beta_t) = -0.60$ Adjusted R-Square = -0.19, D-W Statistics = 1.14, F Statistics = 0.24

Source: Estimated from data collected from NIOT and Socio Economic Accounts published by WIOD.

Variables Used: Gross Value Added, Total Person Engaged, Fixed Capital Stock

Deflator Used: GDP deflator, 2004-05

Note: Regression is carried out with HAC (Newey- West) estimator.

The estimates using Cobb-Douglas Production function using Single deflation shows within the manufacturing sectors, TFP growth is achieved in the industry groups like rubber, plastic and petroleum product, leather product, chemical product, electrical and optical equipment, basic and non-ferrous metal products and manufacturing nec. and recycling. In the

[14] Generally for Agriculture, Land is also taken as input in production function estimation. WIOD do not provide land data. Again the productivity of land is different according to quality of land. Sp getting an aggregate index of land is very difficult. Aggregation is also not possible because of fragmented land holding of the farmer.

other manufacturing groups, the TFP growth is either negative or very close to zero. The labour intensive groups like food Processing, textile product, paper product, wood product, non-metallic mineral products show negligible TFP growth. The estimation using double deflation method results in positive TFP growth in case of food Processing, wood product, paper product, rubber, plastic and petroleum product, chemical product, basic and non-ferrous metal product and electrical and optical equipment (For details See Table 3.2). The TFP growth by double deflated estimates usually gives smaller values than the single deflated estimation. But the results acquired, as the same result also found in Chapter 2 of the study, are contrasting to the literature.

Table 3.2: Estimates of Total Factor Productivity Growth (in percent) (1995-2009)

	C-D Production Function		CES Production Function		Translog Production Function	
	SD	DD	SD	DD	SD	DD
Agriculture and Allied Activities	**-0.05**	**-0.23**	**-0.15**	**1.17**	**0.00**	**16.02**
Mining and Quarrying	**0.21**	**-0.07**	**0.09**	**0.77**	**-0.35**	**2.33**
Food Processing	0.01	0.33	0.00	0.85	-0.11	-6.86
Textiles and Textile Products	0.00	-0.78	0.00	-0.40	0.04	23.03
Leather and Footwear	0.05	-0.64	0.04	0.07	0.65	-13.14
Wood and Products of Wood	-0.20	0.32	-0.48	1.02	-0.72	3.19
Paper, Printing and Publishing	-0.01	1.07	0.00	1.12	2.64	-42.97
Rubber, Plastic and Petroleum	0.28	0.80	0.06	0.18	-0.40	2.45
Chemical Products	0.10	1.24	0.14	1.21	0.71	9.46
Non-Metallic Mineral	-0.03	-0.78	0.02	0.31	-2.27	8.99
Basic and Non-Ferrous metal	0.03	0.68	0.01	0.98	0.70	-12.65
Electrical and Optical Equipment	0.08	1.63	0.07	1.53	5.57	-40.22
Transport Equipment	-0.04	-0.92	0.12	-0.14	-2.62	20.40
Manufacturing Nec. and Recycling	0.13	-1.51	0.17	-1.29	2.50	-25.49
Manufacturing	**-0.02**	**-0.02**	**0.01**	**0.00**	**-0.34**	**0.22**
Electricity, Gas and Water Supply	**-0.01**	**-0.15**	**-0.03**	**-0.13**	**-0.47**	**-2.90**
Construction	**0.04**	**1.02**	**0.07**	**-1.38**	**13.48**	**-246.35**
Services	**0.06**	**-1.95**	**-0.12**	**3.82**	**-5.42**	**244.99**

Source: Estimated from Table 3.1, Table 3.3 and Table 3.4 and Appendix Tables A3.1, A3.2, A3.3, A3.4, A3.5, A3.6.

Note: The estimates of TFP growth for Translog Production Function are obtained at mean value of *logK, log L and time (T)*.[15]

From the estimation of the C-D production function, it is found that the elasticity of output on labour is positive for Agriculture and allied activities, Mining and manufacturing. But

[15] For details of the methodology refer to Ahluwalia (1991: 141-160).

the values are less than one. For other sectors, the elasticity of labour comes out to be negative. When the estimation is through double deflation method, the elasticity comes out to be negative only in case of construction. The capital elasticity of output is found to be positive for each sector. The output growth pulls up the capital accumulation but could not do it for the employment. (For details see Table 3.1, Table A3.1 and A3.2)

The estimation of CES production function gives the idea about the distribution parameter, scale parameter and elasticity of substitution (See Table 3.3 and Table A3.3 and A3.4). For agriculture and allied activities the distribution parameter was estimated to be 1.38, and that of for the Mining sector was 3.89. For the manufacturing sector the estimated parameter was 2.78. Among the manufacturing groups the distribution parameter was negative for the wood product, rubber plastic and petroleum product, non-metallic mineral product, chemical product, electrical and optical equipment, transport equipment and manufacturing nec. and recycling industry. The distribution parameter was negative also for the construction sector (-5.31). For the services the parameter was 3.99 and that of for the electricity, gas and water supply was 2.78. From the estimation of CES production function (Double deflation) it was found that the distribution parameter was 0.13 for agriculture and allied activities, -6.51 for mining and quarrying, 0.10 for the manufacturing, -0.08 for the electricity gas and water supply, -1.02 for the construction and 18.16 for the Services sector. Among the manufacturing industry groups, the parameter is estimated to be positive in case of leather product and footwear, Chemical product, Basic and non-ferrous metal products. For other groups the parameter was negative.

It is found from the estimation that there is operation of increasing returns in case of mining and quarrying, manufacturing, electricity, gas and water supply and construction. Among the manufacturing groups, increasing returns is operational only in textile product, rubber, plastic and petroleum product, transport equipment and manufacturing nec., and recycling. On the other hand, when the CES production function is estimated by double deflated value added method, only construction sector has diminishing returns to scale. Manufacturing groups like leather product, basic and non-ferrous metal product, electrical and optical equipment, transport equipment, and manufacturing nec. and recycling have diminishing returns to scale. (See Table 3.3 and Table A3.3, Table A3.4)

Table 3.3: Estimated CES Production Function for some Sectors (1995-2009)

Model Specification:

$$\ln V_{it} = \beta_1 + \beta_2 \ln L_{it} + \beta_3 \ln K_{it} + \beta_4 (\ln K_{it} - \ln L_{it})^2 + \alpha t$$

Sector		Estimates
Agriculture & allied Activities	S D	$\ln V_{it} = -42.13 - 1.44 \ln L_{it} + 5.19 \ln K_{it} - 0.39(\ln K_{it} - \ln L_{it})^2 - 0.15t$ $t(\beta_1) = -6.09$, $t(\beta_2) = -2.69$, $t(\beta_3) = 15.55$, $t(\beta_4) = -9.96$, $t(\alpha) = -9.54$, Adjusted R-Square = 1.0, D W Statistics = 2.9, F Statistics =1602.41 $\gamma = 5.1\text{E} - 19$, $\mu = 3.75$, $\delta = 1.38$, $\rho = -0.39$, $\sigma = 1.65$
	D D	$\ln V_{it} = 176.88 + 43.45 \ln L_{it} - 49.84 \ln K_{it} + 6.05(\ln K_{it} - \ln L_{it})^2 + 1.17t$ $t(\beta_1) = 0.63$, $t(\beta_2) = 2.63$, $t(\beta_3) = -2.0$, $t(\beta_4) = -2.28$, $t(\alpha) = 1.23$, Adjusted R-Square = 0.17, D W Statistics = 2.68, F Statistics =1.65 $\gamma = 0.18$, $\mu = 1.10$, $\delta = 0.13$, $\rho = 1.21$, $\sigma = 0.45$
Manufacturing	S D	$\ln V_{it} = -2.55 - 2.07 \ln L_{it} - 0.56 \ln K_{it} + 0.14(\ln K_{it} - \ln L_{it})^2 + 0.01t$ $t(\beta_1) = -0.36$, $t(\beta_2) = 2.09$, $t(\beta_3) = -0.52$, $t(\beta_4) = 1.66$, $t(\alpha) = 0.38$, Adjusted R-Square = 1.0, D W Statistics = 1.51, F Statistics =761.95 $\gamma = 7.8E - 02$, $\mu = 1.66$, $\delta = 2.78$, $\rho = -0.04$, $\sigma = 1.05$
	D D	$\ln V_{it} = -6.95 + 1.59 \ln L_{it} + 0.17 \ln K_{it} + 0.08(\ln K_{it} - \ln L_{it})^2$ $t(\beta_1) = -0.30$, $t(\beta_2) = 0.82$, $t(\beta_3) = 0.06$, $t(\beta_4) = 0.35$, Adjusted R-Square = 0.99, D W Statistics = 0.92, F Statistics =274.56 $\gamma = 0.001$, $\mu = 1.76$, $\delta = 0.10$, $\rho = -0.99$, $\sigma = 69.25$
Services	S D	$\ln V_{it} = -23.6 - 4.63 \ln L_{it} + 6.18 \ln K_{it} - 0.34(\ln K_{it} - \ln L_{it})^2 - 0.12t$ $t(\beta_1) = -4.62$, $t(\beta_2) = -3.88$, $t(\beta_3) = 6.12$, $t(\beta_4) = -4.20$, $t(\alpha) = -4.36$, Adjusted R-Square = 1.0, D W Statistics = 1.74, F Statistics =2413.05 $\gamma = 5.6E - 11$ $\mu = 1.55$ $\delta = 3.99$, $\rho = -0.04$, $\sigma = 1.04$
	D D	$\ln V_{it} = 572.61 + 142.78 \ln L_{it} - 151.1 \ln K_{it} + 10.74(\ln K_{it} - \ln L_{it})^2 + 3.82t$ $t(\beta_1) = 1.81$, $t(\beta_2) = 3.74$, $t(\beta_3) = -4.01$, $t(\beta_4) = 4.06$, $t(\alpha) = 2.15$, Adjusted R-Square = 0.44, D W Statistics = 2.85, F Statistics =3.78 $\gamma = 4.8E + 248$, $\mu = -8.32$, $\delta = 18.16$, $\rho = -0.01$, $\sigma = 1.01$

Source: Estimated from data collected from NIOT and Socio Economic Accounts published by WIOD.

Variables Used: Gross Value Added, Total Person Engaged, Fixed Capital Stock

Deflator Used: GDP deflator, 2004-05

Note: Regression is carried out with HAC (Newey- West) estimator.

In the case of agriculture and allied activities, the elasticity of substitution comes out to be 1.65. There are some manufacturing sectors like food processing, textile product, leather products and paper product, the elasticity of substitution is greater than one. In other manufacturing sector the elasticity of substitution is found to be less than unity. These facts also reveal that the C-D production function is not a proper specification for Indian manufacturing sector. The elasticity of substitution is greater than one for sectors like services and electricity, gas and water supply. One point that comes out from the estimation is that the elasticity of substitution is higher in the case of the manufacturing industries where the share of unorganised sector is high. Food products, textile products, leather products, recycling and manufacturing nec., have a high unorganised share.

The concept of elasticity of substitution is related to the share of the factors i.e. capital and labour in the output. If the elasticity of substitution is zero, the coefficients estimated of production function is fixed. An infinite elasticity of substitution means the marginal productivities of labour and capital are independent of their quantity. If the elasticity of substitution falls in between zero to one range, then increase in the capital/output ratio will cause a decline in the marginal productivity of capital and thus a falling share of capital in output. Likewise an elasticity of substitution greater than one will lead to an increase in the share of capital.[16] Unitary elasticity of substitution refers to as the fall in rate of profit will exactly cancel out the increase in capital/income ratio and thus the share of capital and labour would remain the same. It is found that the trend in share of capital has fallen for the sectors like electricity, gas and water supply; and increased for agriculture and allied activities, mining and quarrying, manufacturing as well as for the registered manufacturing and services. From Table 3.3, it is confirmed that the elasticity of substitution for the agriculture and allied, manufacturing and services sectors is estimated to be greater than one. So the result confirms the increase in share of capital.[17]

Elasticity of substitution being greater than one in the capitalist countries means the share of profit in the NVA will keep rising. The accumulation of capital in sectors with greater than one elasticity of substitution will prevail over the decline in the rate of profit effect on the share of profit.

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[16] Piketty (2013: 217)

[17] The share of capital and Labour compensation from gross value added shows for different sectors the share of capital has increased during the period of study. Details of the trends of factor shares is explained in Appendix (A3.3) to the chapter.

CES production function also gives an estimate of TFP growth. The estimates using single deflated real value added found negative TFP growth for Agriculture & allied activities, and Services sector. TFP growth in case of the manufacturing sector was 0.01%. For the manufacturing sectors like Food Processing, Textile, Paper Product, Non-metallic mineral, Basic and non-ferrous metal products the TFP growth is very slow. In contrast to these observations, the double-deflation method shows TFP growth in case of Agriculture and allied activities, and Services are positive. TFP growth in the Manfactuirng sector is zero. Within the manufacturing sectors TFP growth is negative for Textile, Transport equipment and Manufacturing nec. and Recycling, From Table 3.3, it can also be observed that for the manufacturing sector, the CES production function has been affected by multi-co linearity problem as the F statistics is significant, but the t-values are insignificant.

Table 3.4 gives the estimates of Translog production function by single deflation and double deflation method. The single deflated estimates show there is negative TFP growth in case of agriculture and allied activities, manufacturing, services and electricity, gas and water supply. Positive TFP growth is achieved in construction. The double deflated estimates give negative TFP growth only for construction and electricity, gas and water Supply. The value of TFP growth is very high in the translog production function than the C-D production function. The TFP growth for manufacturing from single deflated estimation is found to be -0.34. The rate of change in the TFP growth, in this case, is found to be 0. So the estimates show there is no room for improvement in the manufacturing sector. The service sector TFP growth is a negative of 5.42, and the estimated rate of change in TFP growth is 0.7.The TFP growth in case of agriculture and allied activities is found to be zero. The rate of change in TFP growth is also negligible.

Table 3.4: Estimated Translog Production Function for some Sectors (1995-2009)

Model Specification:

$$v = \beta_0 + \beta_l l + \beta_k k + \beta_t T + {}^1\!/_2\, \beta_{ll} l^2 + {}^1\!/_2\, \beta_{kk} k^2 + \beta_{lk} lk + \beta_{lt} lT + \beta_{kt} kT + {}^1\!/_2\, \beta_{tt} T^2$$

Sector	Model	Estimates
Agriculture & allied Activities	S D	$v = -4524.6 + 517.3l + 1.77k - 17.9T - {}^1\!/_2\, 7.8l^2 - {}^1\!/_2\, 1.1k^2 - 8.8lk + 1.0lT + 0.4kT$ $t(\beta_0) = -1.4$, $t(\beta_l) = 1.4$, $t(\beta_k) = 177.0$, $t(\beta_t) = -17.9$, $t(\beta_{ll}) = -1.1$, $t(\beta_{kk}) = -0.7$, $t(\beta_{lk}) = -0.6$, $t(\beta_{lt}) = 0.8$, $t(\beta_{kt}) = 0.5$, $t(\beta_{tt}) = -0.5$ Adjusted R-Square = 1.0 , D W Statistics = 3.2 , F Statistics = 722.1
	D D	$v = 841324.3 + 109939.7l + 21893.4k - 3002.3T - {}^1\!/_2\, 1781l^2 - {}^1\!/_2\, 59.9k^2 - 1482.2lk + 204.1lT + 32.1kT - {}^1\!/_2\, 2.2T^2$ $t(\beta_0) = -1.3$, $t(\beta_l) = 1.3$, $t(\beta_k) = 1.0$, $t(\beta_t) = -1.1$, $t(\beta_{ll}) = -1.4$, $t(\beta_{kk}) = -0.6$ $t(\beta_{lk}) = -1.1$, $t(\beta_{lt}) = 1.2$, $t(\beta_{kt}) = 0.7$, $t(\beta_{tt}) = -0.8$ Adjusted R-Square = , D W Statistics = , F Statistics =
Manufacturing	S D	$v = 1324 - 86.3l - 112.8k + 16.1T - {}^1\!/_2\, 0.5l^2 + {}^1\!/_2\, 0.6k^2 + 7.1lk - 0.7lT - 0.5kT$ $t(\beta_0) = 0.2$, $t(\beta_l) = -0.1$, $t(\beta_k) = -0.2$, $t(\beta_t) = 0.2$, $t(\beta_{ll}) = 0$, $t(\beta_{kk}) = 0.2$, $t(\beta_{lk}) = 0.3$, $t(\beta_{lt}) = -0.2$, $t(\beta_{kt}) = -0.2$ Adjusted R-Square = 1.0, D W Statistics = 2.1, F Statistics =520.7
	D D	$v = 146.1 + 69.2l - 63.8k - 0.1T - {}^1\!/_2\, 5.5l^2 - {}^1\!/_2\, 0.8k^2 + 10.7lk - 0.3lT + 0.3kT$ $t(\beta_0) = 0$, $t(\beta_l) = 0$, $t(\beta_k) = -0.1$, $t(\beta_t) = 0$, $t(\beta_{ll}) = -0.2$, $t(\beta_{kk}) = -0.1$, $t(\beta_{lk}) = 0.2$, $t(\beta_{lt}) = 0$, $t(\beta_{kt}) = 0.1$, $t(\beta_{tt}) = 0$ Adjusted R-Square = 1, D W Statistics = 1.9 , F Statistics = 145.5
Services	S D	$v = 20351.8 - 1406.1l - 1567.2k + 225.8T + {}^1\!/_2\, 20.7l^2 + {}^1\!/_2\, 19.6k^2 + 29.5lk - 5.7\, \beta_{lt} lT - 10.2kT + {}^1\!/_2\, 0.7T^2$ $t(\beta_0) = 0.6$, $t(\beta_l) = -0.6$, $t(\beta_k) = -0.5$, $t(\beta_t) = 0.5$, $t(\beta_{ll}) = 1.5$, $t(\beta_{kk}) = 0.8$, $t(\beta_{lk}) = 0.2$, $t(\beta_{lt}) = -0.4$, $t(\beta_{kt}) = -0.7$, $t(\beta_{tt}) = 0.6$ Adjusted R-Square = 1.0 , D W Statistics = 2.2 , F Statistics = 1924.4
	D D	$v = 1319932 + 111079.1l + 87408.8k - 13187.1T - {}^1\!/_2\, 738.1l^2 - {}^1\!/_2\, 503.2k^2 - 4909.8lk + 650.9lT + 367.8kT - {}^1\!/_2\, 30.1T^2$ $t(\beta_0) = -0.7$, $t(\beta_l) = 0.9$, $t(\beta_k) = 0.6$, $t(\beta_t) = -0.7$, $t(\beta_{ll}) = -1.1$, $t(\beta_{kk}) = -0.4$, $t(\beta_{lk}) = -0.8$, $t(\beta_{lt}) = 0.9$, $t(\beta_{kt}) = 0.5$, $t(\beta_{tt}) = -0.6$ Adjusted R-Square = 0.4 , D W Statistics = 2.4 , F Statistics = 1.9

Source: Estimated from data collected from NIOT and Socio Economic Accounts published by WIOD.

Variables Used: Gross Value Added, Total Person Engaged, Fixed Capital Stock

Deflator Used: GDP deflator, 2004-05

Note: Regression is carried out with HAC (Newey-West) estimator.

Within the manufacturing sector, TFP growth estimated through single deflation is found to be negative in case of rubber, plastic and petroleum product, transport equipment, non-metallic mineral product, wood product and food products. For other groups, the TFP growth is estimated to be positive. But the estimates by double deflation method shows positive TFP growth in case of textile product, wood product, rubber, plastic and petroleum product, chemical products, non-metallic mineral products and transport equipment. This is a different result as the sectors with negative TFP growth in single-deflation show positive TFP growth when calculated through double deflation. The coefficient β_{lt} and β_{kt} show the technical bias toward labour and capital respectively. The single deflation estimates show that agriculture and allied activities, and mining are using labour bias technique whereas the double-deflation method hints at labour using bias in services also. Within the manufacturing groups, the labour intensive groups only show labour using bias in the production. (See appendix Table A3.5, Table A3.6)

3.4 Estimation of production function and total factor productivity growth for registered manufacturing:

Production Function estimation is carried out in the study for the period 1980-81 to 2012-13 for the Registered Manufacturing sector. Annual Survey of Industries (ASI) data is used for the estimation. In the study Cobb-Douglas Production Function, CES Production Function and Translog Production Function are estimated. For the period 1980-81 to 2012-13, all three specifications is estimated for single deflated real value added. For the period 1995-2011, all the three production function are estimated with both single deflated and double deflated real value added. Gross value added, Total person engaged and Fixed capital data are collected from ASI to be used as proxy for output, Labour and Capital respectively.

TFP growth through single deflation in Registered Manufacturing was 0.06 during the period 1980-81 to 2012-13. The TFP growth for the very sector during the period 1995 to 2009 was 0.06 percent, and on the other hand the double deflated TFP growth estimate for the registered manufacturing was 0.05 percent for the same period. The CES production function also results in the same TFP growth as estimated by the C-D production function. But the elasticity of substitution was estimated to be significantly different from 1. The Translog production function by single-deflation for the period 1980-81 to 2012-13 is being estimated for the registered manufacturing. The estimate shows there is negative TFP growth in the registered manufacturing. The TFP growth recorded is 0.07 percent for the period 1980-81 to 2012-13. The single deflation estimates show negative TFP growth of -0.32 percent for the manufacturing sector for the period 1995 to 2009 whereas double deflated estimation shows negative TFP growth (-0.02 percent) for the registered manufacturing during the period 1995-2011.

Cobb-Douglas Specification

The estimation of Cobb-Douglas specification for the different manufacturing industry groups for the period 1980-81 to 2012-13 shows highest TFP growth in case of Rubber, plastic and petroleum product. The TFP growth was found to be 0.08 for this sector. The estimates also suggest negative TFP growth for food processing and wood products. High TFP growth was registered in the sectors like paper products, basic and non-ferrous metal products, electrical & optical equipment, transport equipment and manufacturing nec., and recycling. Other sectors like textile products, leather product, chemical products, and non-metallic mineral products have very low TFP growth during the period 1980-81 to 2012-13.

The estimation of Cobb-Douglas production function for the registered manufacturing for the period 1995 to 2011 shows 0.060% TFP growth. High TFP growth (single deflation) was registered in transport equipment (0.09%), rubber, plastic and petroleum product (0.07%), electrical and optical equipment (0.05%), basic and non-ferrous metal (0.05%) and paper product (0.051%). During the period, food products, textile product, leather products, wood product, non-metallic mineral product have low TFP growth. The double deflation measure of TFP growth for the period 1995 to 2011 was 0.05% for the registered manufacturing. The double deflation estimation shows negative TFP growth for food Processing, rubber, plastic and petroleum product. Industry groups like electrical and optical equipment, transport equipment, non-metallic mineral product, textile product, leather product, paper product registered high TFP growth. Other sectors like wood product, chemical products, basic and non-ferrous metal product and Manufacturing nec., and recycling registered very low TFP growth during the study period 1995 to 2011.

Table 3.5: Estimated Production Functions for Registered Manufacturing

C-D Production Function	SD (1980-81 to 2012-13)	$\log V = 0.397 + 0.965 \log L + .001 \log K + 0.057t$ $t(\alpha) = 0.23,\ t(\beta_l) = 7.37,\ t(\beta_k) = 0.011,\ t(\beta_t) = 9.06$, Adjusted R-Square = 0.99, D-W Statistics = 1.29 , F Statistics = 2673.2
	S D (1995 to 2011)	$\log V = -0.094 + 1.243 \log L - 0.174 \log K + 0.06t$ $t(\alpha) = -0.068,\ t(\beta_l) = 6.97,\ t(\beta_k) = -1.17,\ t(\beta_t) = 8.07$ Adjusted R-Square = 0.99, D-W Statistics = 1.95 , F Statistics = 417.63
	D D (1995 to 2011)	$\log V = -10.06 + 1.28 \log L + 0.36 \log K + 0.05t$ $t(\alpha) = -4.62,\ t(\beta_l) = 6.54,\ t(\beta_k)2.27,\ t(\beta_t) = 5.78$ Adjusted R-Square = 0.99, D-W Statistics = 1.95 , F Statistics = 527.86
CES Production Function	SD (1980-81 to 2012-13)	$\ln V_{it} = -1.72 + 0.14 \ln K_{it} + 0.96 \ln L_{it} - 0.07(\ln K_{it} - \ln L_{it})^2 + 0.06t$ $t(\beta_1) = -1.28,\ t(\beta_2) = 2.25,\ t(\beta_3) = 12.59,\ t(\beta_4) = -2.91,\ t(\alpha) = 10.7$, Adjusted R-Square = 1.0, D W Statistics = 1.74, F Statistics =2413.05 $\gamma = 2E-01,\ \mu = 1.10,\ \delta = 0.13,\ \rho = 1.21,\ \sigma = 0.45$
	S D (1995 to 2011)	$\ln V_{it} = -4.39 + 1.17 \ln K_{it} + 0.09 \ln L_{it} - 0.36(\ln K_{it} - \ln L_{it})^2 + 0.06t$ $t(\beta_1) = -1.34,\ t(\beta_2) = 1.5,\ t(\beta_3) = 0.14,\ t(\beta_4) = -1.85,\ t(\alpha) = 7.61$, Adjusted R-Square = 0.99, D W Statistics = 2.37, F Statistics =325.75 $\gamma = 1E-02,\ \mu = 1.26,\ \delta = 0.93,\ \rho = 8.51,\ \sigma = 0.11$
	D D (1995 to 2011)	$\ln V_{it} = -10.17 + 0.393 \ln K_{it} + 1.25 \ln L_{it} - 0.01(\ln K_{it} - \ln L_{it})^2 + 0.05t$ $t(\beta_1) = -2.05,\ t(\beta_2) = 0.28,\ t(\beta_3) = 1.04,\ t(\beta_4) = -0.02,\ t(\alpha) = 4.78$, Adjusted R-Square = 0.99, D W Statistics = 1.95, F Statistics =365.46 $\gamma = 4E-05,\ \mu = 1.65,\ \delta = 0.24,\ \rho = 0.06,\ \sigma = 0.94$
Translog Production Function	SD (1980-81 to 2012-13)	$v = 130.09 + 44.14l - 25.99k + 1.47T - {}^1/_2\, 0.79l^2 + {}^1/_2\, 0.33k^2 + 0.37lk + 0.62lT - 0.15kT + {}^1/_2\, 0.007T^2$ $t(\beta_0) = -0.44,\ t(\beta_l) = 1.18\ \ t(\beta_k) = -1.49,\ t(\beta_t) = 1.01, t(\beta_{ll}) = -0.98$, $t(\beta_{kk}) = 1.09,\ t(\beta_{lk}) = 0.28,\ t(\beta_{lt}) = 0.77,\ t(\beta_{kt}) = -1.70,\ t(\beta_{tt}) = 1.93$ Adjusted R-Square = 0.99, D W Statistics = 2.13 , F Statistics = 1315.9
	S D (1995 to 2011)	$v = 547.43 + 73.12l - 4.39k - 1.06T - {}^1/_2\, 0.65l^2 - {}^1/_2\, 0.52k^2 - 1.83lk + 0.08lT - 0.15kT - {}^1/_2\, 0.01T^2$ $t(\beta_0) = -1.06,\ t(\beta_l) = 1.13,\ t(\beta_k) = -0.15,\ t(\beta_t) = 0.51,\ t(\beta_{ll}) = -0.37,\ t(\beta_{kk}) = 0.49,\ t(\beta_{lk}) = -0.42,\ t(\beta_{lt}) = 0.55,\ t(\beta_{kt}) = -0.94$, $t(\beta_{tt}) = 1.39$ Adjusted R-Square = 0.98, D W Statistics = 2.48 , F Statistics = 144.5
	D D (1995 to 2011)	$v = 916.15 - 64.09l - 47.94k + 5.38T + {}^1/_2\, 1.08l^2 + {}^1/_2\, 0.73k^2 - 0.13lk - 0.12lT - 0.19kT - {}^1/_2\, 0.005T^2$ $t(\beta_0) = 0.72,\ t(\beta_l) = -0.41,\ t(\beta_k) = -1.09,\ t(\beta_t) = 1.056,\ t(\beta_{ll}) = 0.37$, $t(\beta_{kk}) = 0.43,\ t(\beta_{lk}) = 0.02,\ t(\beta_{lt}) = -0.29,\ t(\beta_{kt}) = -0.78,\ t(\beta_{tt}) = 044$ Adjusted R-Square = 0.98, D W Statistics = 2.42 , F Statistics = 120.94

Source: Estimated from data collected from ASI.

Variable Used: Gross Value Added, Total Person Engaged, Fixed capital

Deflator Used: GDP deflator, 2004-05

Note: Regression is carried out with HAC (Newey-West) estimator.

From the estimation of C-D production function, it was found that the elasticity of output with respect to labour for the registered manufacturing was positive, but the value was less than one (0.965) for the period 1980-81 to 2012-13. The elasticity of labour comes out to be negative for the food processing industry. The elasticity was high in case of Chemical product and Non-metallic mineral product. For the period 1995 to 2011 the elasticity of output with respect to labour was 1.23 for the registered manufacturing sector. When the estimation is through double deflation method, the elasticity comes out to be 1.28 for the registered manufacturing sector for the period 1995 to 2011.

CES Specification

The CES production function for the registered manufacturing industry groups is estimated and presented in Table A3.10, Table A3.11 and Table A3.12. The distribution parameter for the manufacturing during the period 1980-81 to 2012-13 was estimated to be 0.13. The estimated parameters for other industry groups showed the parameter was high for food processing, leather product, wood product, rubber, plastic and petroleum product and chemical products. During the period 1995-2011 the distribution parameter is estimated to be 0.93. During this period, the parameter is positive only for wood product, chemical product, basic metal and non-ferrous metal products, transport equipment and manufacturing nec., and recycling. The estimation of CES production function by double deflation shows the distribution parameter to be 0.24. The parameter was estimated to be negative in case of Food Processing, Textile product, wood product, chemical product and electrical and optical products.

The scale parameter for the registered manufacturing is estimated to be 1.10 for the period 1980-81 to 2012-13. This suggests the operation of increasing returns in case of registered manufacturing. For sectors like textile products, leather product, chemical product, non-metallic mineral product, electrical and optical products, the parameter is estimated to be greater than one which indicates the operation of increasing returns to scale. The single deflated estimation of scale parameter for the period 1995 to 2011 also suggests at increasing returns to scale in case of registered manufacturing. During this period, increasing returns to scale operates in wood products, chemical products, non-metallic mineral products and manufacturing nec., and recycling industry. The double deflated estimation shows higher scale parameter. Diminishing returns to scale operates only in the food processing, textile product, leather product, paper product, non-metallic mineral product and basic and non-ferrous metal products.

The elasticity of substitution is found to be very low at 0.45 for the registered manufacturing during the period 1980-81 to 2012-13. The elasticity is estimated to be greater than one in case of food processing, rubber, plastic and petroleum product and manufacturing nec., and recycling. The single deflated measure of elasticity for the period 1995-2011 was found to be 0.11. During the period only for chemical products, the elasticity is greater than one. The double deflated measure shows elasticity of substitution for the registered manufacturing for the period 1995 to 2011 was 0.94. Elasticity of substitution is found to be greater than one for chemical product (2.42) and electrical and optical equipment (3.14) and is estimated to be negative for food processing and wood product. The estimated elasticity of substitution for the registered manufacturing shows the share of profit in its NVA should go down in the long run. But it is found that the share of profit has increased for the registered manufacturing during the period of study. So the CES estimates are mis-specified for the registered manufacturing. For manufacturing groups like chemical product, electrical and optical equipment, the CES fit may give better result than C-D production function but it is not suitable for the overall registered manufacturing.

Table 3.6: Estimates of Total Factor Productivity Growth for Registered Manufacturing (in percent)

	Cobb-Douglas Production Function			CES Production Function			Translog Production Function		
	1980-81 to 2012-13	1995-2011	1995-2011	1980-81 to 2012-13	1995-2011	1995-2011	1980-81 to 2012-13	1995-2011	1995-2011
	SD	SD	DD	SD	SD	DD	SD	SD	DD
Food Processing	-0.01	0.01	-0.05	-0.01	0.02	-0.02	0.27	0.79	0.16
Textile Products	0.03	0.03	0.08	0.03	0.02	0.08	0.00	-0.06	0.02
Leather Product	0.01	0.01	0.06	0.01	0.02	0.07	0.10	0.54	0.26
Wood Products	-0.03	0.01	0.03	-0.03	0.01	0.05	-0.07	-0.79	-0.52
Paper Product	0.05	0.06	0.06	0.05	0.05	0.05	0.04	-0.06	-0.08
Rubber, Plastic and Petroleum	0.08	0.07	-0.11	0.08	0.08	-0.10	-0.34	-1.41	-0.11
Chemical Products	0.02	0.02	0.03	0.02	0.03	0.04	0.07	-0.18	0.02
Non-Metallic Mineral Product	0.02	0.01	0.08	0.01	0.05	0.12	0.05	-0.36	0.34
Basic and Non-Ferrous metal Product	0.05	0.05	0.04	0.05	0.05	0.04	0.06	0.00	0.03
Electrical and Optical Equipment	0.04	0.05	0.10	0.04	0.05	0.09	0.05	-0.20	0.06
Transport Equipment	0.06	0.09	0.16	0.06	0.09	0.16	0.21	0.63	0.23
Manufacturing, Nec; Recycling	0.04	-0.02	0.02	0.05	-0.01	0.02	0.84	0.48	-0.04
Manufacturing	**0.06**	**0.06**	**0.05**	**0.06**	**0.06**	**0.05**	**-0.07**	**-0.32**	**-0.02**

Source: Estimated from Table 3.5, and Appendix A3.4

Note: The estimates of TFP growth for Translog Production Function are obtained at mean value of *logK, log L and time (T)*.

TFP growth in the registered manufacturing was 0.06 percent during the period 1980-81 to 2012-13. The TFP growth was estimated to be same also for the period 1995 to 2011 and 0.05 percent when estimated by double deflation method during the same period. TFP growth in rubber, plastic and petroleum product was 0.08 percent during the period 1980-81 to 2012-13 and it was the highest among manufacturing groups. Transport equipment showed highest TFP growth of 0.09 percent during the period 1995-2011 when estimated through double deflation. When estimated through double deflation, TFP growth is estimated to be negative for the Rubber, Plastic and Petroleum product, and Food Processing. High TFP growth is estimated in Transport equipment, Non-metallic mineral product, Textile product, and Electrical and Optical equipment.

Translog specification

For the period 1980-81 to 2012-13, TFP growth in registered manufacturing as estimated by Translog Production function was a negative 0.07 percent. The estimation also shows high TFP growth in case of manufacturing nec., and recycling, food processing, transport equipment and leather product. The estimates also reveal negative TFP growth in wood product, rubber, plastic and petroleum product. The positive 'β_{lt}' coefficient represent the technical bias towards labour for textile product, leather product, wood product, paper product, chemical product, manufacturing nec., and recycling as well as for the entire manufacturing.

Table A3.14 represents the estimates of Translog production function for registered manufacturing groups by single deflation method for the period 1995 to 2011. There is positive TFP growth for the industry groups like food processing (0.79), leather product (0.54), transport equipment (0.63) and manufacturing nec. and recycling (0.48). 'β_{lt}' is positive for the food processing, textile product, leather product, wood product, paper product, chemical product, manufacturing nec., and recycling and the overall manufacturing. This shows a labour using bias in the registered manufacturing.

The double deflated Translog production function for the registered manufacturing is presented in Table A3.15. TFP growth for the registered manufacturing was -0.02 percent for the period 1995 to 2011. TFP growth is found to be negative in wood product, paper product, rubber, plastic and petroleum product, manufacturing nec., and recycling. The 'β_{lt}' is estimated to be positive for food processing, wood product, paper product, chemical product, non-metallic mineral product. These groups have labour using bias.

3.5 Summary

The estimates C-D specification from single deflation method show TFP growth is registered in Services at 0.06% during the period 1995 to 2009. Manufacturing TFP has a negative growth of 0.02%. Agriculture and allied activities have a negative TFP growth. On the other hand the double deflation estimates show TFP growth was -1.95%, -0.02% and -0.23% for services, manufacturing and agriculture sector respectively. The labour intensive manufacturing sectors like paper product, wood product, non-metallic mineral products show negative TFP growth while for food processing and textile the estimate is very negligible. The estimation using double deflation method results in positive TFP growth in case of food processing, wood product, paper product, rubber, plastic and petroleum product, chemical product, basic metal product and electrical and optical equipment.

The CES production function estimates using single deflated real value added found negative TFP growth for agriculture & allied activities, services and electricity, gas and water supply. TFP growth in case of manufacturing sector was 0.01%. For the manufacturing sectors like food processing, textile product, paper product, non-metallic mineral, basic and non-ferrous metal products the TFP growth is very slow. In contrast to these observations, the double deflation method shows positive TFP growth in case of agriculture and allied activities, and services.

The estimates of Translog production function by single deflation show there is TFP growth only in Construction. The double deflated estimates give positive TFP growth only in Agriculture and allied activities, Mining and quarrying and Manufacturing. Within the manufacturing sector, TFP growth is found to be negative in case of food processing, wood product, rubber, plastic and petroleum product, non-metallic mineral product and transport equipment. For other groups the TFP growth is estimated to be positive. But the estimates by double deflation method shows negative TFP growth in case of food processing, leather product, paper product, basic and non-ferrous metal product, electrical and optical equipment and manufacturing nec. and recycling. The single deflation estimates show that Agriculture and allied activities, and Mining are using labour bias technique whereas the double deflation method hints at labour using bias in services also. Within the manufacturing groups the labour intensive groups only show labour using bias in the production.

The TFP growth from Cobb-Douglas production function for the registered manufacturing during the period 1995 to 2011 was 0.06 percent and on the other hand the double deflated TFP growth estimate for the registered manufacturing was 0.05 percent for the same period. The CES production function also results in the same TFP growth as estimated by C-D production function. But the elasticity of substitution was estimated to be significantly different from 1. The single deflation estimates of Translog production function show negative TFP growth of 0.32% for the registered manufacturing sector for the period 1995 to 2011 whereas double deflated estimation shows negligible TFP growth (-0.02%) for the registered manufacturing during the period 1995 to 2011.

The estimates of Cobb-Douglas production function, and CES production function or Translog production function did not confirm Total Factor Productivity Growth in different sectors during the period 1995-2009 as the estimates differed according to the model specification and use of single deflated and double deflated value added. The estimates of CES production function show that the elasticities of factor substitution in the different sectors are not equal to 1. For the Cobb-Douglas production function, unitary elasticity of substitution is one property of the function. So the C-D specification for different sectors is misrepresented.

The statistical problems like endogeneity of capital, multicollinearity among explanatory variables do not give a thumb up to the production function estimates. The TFP growth estimates through production function do not include the effect of scale economies. All these models are essentially supply-side model. Growth may be pursued as the outcome of the process of both the creation of capacity to produce and the growth of demand for the product. Investment takes place as it creates the capacity to produce and generates Aggregate Demand. The insertion of index of educational attainment in production function may constitute a gross misspecification of the relation between education and the production dynamics. New technology increases output by expanding demand in existing lines of production via cost reduction and by creating demand for new products. The growth models based on production function do not help in imagining the process of development of market. So production function only captures the proximate causes of growth which itself is intrinsic to a self-referential element in explaining growth. On the other hand demand driven growth models are free from such circularity.

Chapter 3 along with Chapter 2 deals with the conventional approaches to measurement of TFP growth. Set aside the problems, the two methods only pass information about TFP growth. Acknowledging TFP Growth as the explanation of difference in growth in cross-country analysis, more fundamentally to say, it is an estimated figure which makes no pathway to the process, causes and policy to track and govern the growth pattern. So the next chapter will look into a simple alternative from the literature of Adam Smith which set the problem of productivity at the centre of growth and will be much more helpful in policy formation.

Appendix

A3.1 Properties of C-D production function

1. The C-D production function is a homogenous production function of degree (α + β).

Proof:

Let the production function be

$$Q = f(L, K) = A\, L^{\alpha} K^{\beta}$$

Suppose, there is 'θ' times change in the factor inputs

So the production function would be,

$$f(\theta L, \theta K) = A\,(\theta L)^{\alpha}(\theta K)^{\beta} = A\,\theta^{\alpha+\beta} L^{\alpha} K^{\beta} = \theta^{\alpha+\beta} f(L, K) = \theta^{\alpha+\beta} Q$$

This shows C-D Production function is homogeneous of degree (α + β).

If (α+β) > 1, then the production function exhibits increasing returns to scale.

If (α+β) = 1, then the production function exhibits constant returns to scale.

If (α+β) < 1, then the production function exhibits diminishing returns to scale.

2. The marginal products of the factors depend on their average products.

Proof:

$$Q = A\, L^{\alpha} K^{\beta}$$

The marginal product of a factor is the first order partial derivative of output with respect to that particular factor. So, Marginal product of labour will be

$$MP_L = \frac{\partial Q}{\partial L} = \frac{\partial (AL^{\alpha}K^{\beta})}{\partial L} = \alpha A L^{\alpha-1} K^{\beta} = \alpha\, \frac{Q}{L} = \alpha\, AP_L$$

Similarly for marginal product of capital,

$$MP_K = \frac{\partial Q}{\partial K} = \frac{\partial (AL^{\alpha}K^{\beta})}{\partial K} = \beta A L^{\alpha} K^{\beta-1} = \beta\, \frac{Q}{L} = \beta\, AP_K$$

In the case of a C-D production function, the marginal products are the multiplication of the average product of the factor and the distributive share.

3. C-D production function satisfies Euler's theorem.

i.e. $$L\frac{\partial Q}{\partial L} + K\frac{\partial Q}{\partial K} = (\alpha + \beta)Q$$

Proof:

From property 2, we get

$$L\frac{\partial Q}{\partial L} + K\frac{\partial Q}{\partial K} = L\,\alpha\frac{Q}{L} + K\,\beta\,\frac{Q}{K} = \alpha\,Q + \beta\,Q = (\alpha + \beta)Q$$

4. The elasticity of substitution for the C-D production function is one.

Proof:

$$\text{Elasticity of Substitution } (\sigma) = \frac{\text{proportionate change in } (\frac{K}{L})}{\text{Proportionate change in factor price ratio}} \qquad (1a)$$

Factor price ratio is equal to the marginal rate of technical substitution of capital for labour. So we can rewrite equation (1a) as,

$$\text{Elasticity of Substitution } (\sigma) = \frac{\text{proportionate change in } (\frac{K}{L})}{\text{Proportionate change in } MRTS_{LK}} \qquad (2a)$$

Again $MRTS_{LK}$ is the ratio of marginal products of the factors.

So $$MRTS_{LK} = \frac{MP_L}{MP_K}$$

So equation (2a) can be expressed as,

$$\text{Elasticity of Substitution } (\sigma) = \frac{\partial\left(\frac{K}{L}\right)}{\left(\frac{K}{L}\right)} \Bigg/ \frac{\partial\left(\frac{MP_L}{MP_K}\right)}{\left(\frac{MP_L}{MP_K}\right)} \qquad (3a)$$

Substituting the values of MP_L and MP_K from property 2 in equation (3a), then we will get

$$\text{Elasticity of Substitution } (\sigma) = \frac{\partial\left(\frac{K}{L}\right)}{\left(\frac{K}{L}\right)} \Bigg/ \frac{\partial\left(\frac{\alpha\frac{Q}{L}}{\beta\frac{Q}{K}}\right)}{\left(\frac{\alpha\frac{Q}{L}}{\beta\frac{Q}{K}}\right)} \qquad (4a)$$

From equation (4a),

$$\text{Elasticity of Substitution } (\sigma) = \frac{\partial\left(\frac{K}{L}\right)\ \frac{\alpha}{\beta}\ \left(\frac{K}{L}\right)}{\left(\frac{K}{L}\right)\ \frac{\alpha}{\beta}\ \partial\left(\frac{K}{L}\right)} = 1$$

5. The exponents α and β represents the output elasticities of labour and capital.

Proof:

$$Q = A\, L^{\alpha} K^{\beta}$$

Taking logarithm both the side,

$$logQ = \log A + \ \alpha \log L + \ \beta \log K \tag{5a}$$

Taking the derivative of (5a) with respect to (log L), then we get

$$\frac{d(\log Q)}{d(\log L)} = \ \alpha$$

and, taking the derivative of (5a) with respect to (log K), then we get

$$\frac{d(\log Q)}{d(\log K)} = \ \beta$$

A3.2 Properties of CES production function

1. CES production function is a homogenous production function exhibiting different returns to scale.

Proof:

The general form of CES production function is

$$Q = f(K, L) = A\ [\alpha K^{-\rho} + \ \beta L^{-\rho}]^{-\mu/\rho}$$

Suppose, there is 'θ' times change in the factor inputs

$$f(\theta K, \theta L) = A\ [\alpha(\theta K)^{-\rho} + \ \beta(\theta L)^{-\rho}]^{-\mu/\rho} \tag{6a}$$

Expanding (6a),

$$f(\theta K, \theta L) = A\ [\alpha\theta^{-\rho} K)^{-\rho} + \ \beta\theta^{-\rho} L^{-\rho}]^{-\mu/\rho}$$

From the above equation,

$$f(\theta K, \theta L) = (\theta^{-\rho})^{\frac{-\mu}{\rho}} A\, [\alpha K)^{-\rho} + \beta L^{-\rho}]^{-\mu/\rho} = \theta^{\mu} f(K, L) = \theta^{\mu} Q$$

So, it is a homogenous production function of degree 'μ'.

If $\mu > 1$, then the production function exhibits increasing returns to scale.

If $\mu = 1$, then the production function exhibits constant returns to scale.

If $\mu < 1$, then the production function exhibits diminishing returns to scale.

2. CES production function satisfies Euler's Theorem.

$$L\frac{\partial Q}{\partial L} + K\frac{\partial Q}{\partial K} = \mu Q$$

Proof:

$$Q = A\, [\alpha K^{-\rho} + \beta L^{-\rho}]^{-\mu/\rho} \quad (7a)$$

Taking the partial derivative of Q with respect to K, then

$$\frac{\partial Q}{\partial K} = \frac{\partial\left\{A\, [\alpha K^{-\rho} + \beta L^{-\rho}]^{-\mu/\rho}\right\}}{\partial K} \quad (8a)$$

Expanding the equation (8a), we shall get

$$\frac{\partial Q}{\partial K} = \frac{-\mu}{\rho} \frac{\left\{A\, [\alpha K^{-\rho} + \beta L^{-\rho}]^{-\mu/\rho}\right\}}{[\alpha K^{-\rho} + \beta L^{-\rho}]} \alpha\, (-\rho) K^{-(1+\rho)}$$

Further expanding it, we can rewrite the equation as,

$$\frac{\partial Q}{\partial K} = \mu\, \frac{Q}{[\alpha K^{-\rho} + \beta L^{-\rho}]}\, \alpha\, K^{-(1+\rho)} \quad (9a)$$

Then multiplying K both side of equation (9a),

$$K\, \frac{\partial Q}{\partial K} = \frac{\mu \alpha\, K^{-\rho}.Q}{[\alpha K^{-\rho} + \beta L^{-\rho}]} \quad (10a)$$

Similarly by taking partial derivative of Q with respect to L

$$\frac{\partial Q}{\partial L} = \mu\, \frac{Q}{[\alpha K^{-\rho} + \beta L^{-\rho}]}\, \beta\, L^{-(1+\rho)} \quad (11a)$$

Then Multiplying L both side of the equation (11a),

$$L\ \frac{\partial Q}{\partial L} = \frac{\mu\beta\ L^{-\rho}.Q}{[\alpha K^{-\rho} + \beta L^{-\rho}]} \tag{12a}$$

Summing up equation (10a) and (11a) we shall get,

$$K\ \frac{\partial Q}{\partial K} + L\ \frac{\partial Q}{\partial L} = \frac{\mu\alpha\ K^{-\rho}.Q}{[\alpha K^{-\rho} + \beta L^{-\rho}]} + \frac{\mu\beta\ L^{-\rho}.Q}{[\alpha K^{-\rho} + \beta L^{-\rho}]} \tag{13a}$$

Taking 'µQ' common on the right-hand side of equation (13a)

$$K\ \frac{\partial Q}{\partial K} + L\ \frac{\partial Q}{\partial L} = \mu Q\left[\frac{\alpha\ K^{-\rho}}{[\alpha K^{-\rho} + \beta L^{-\rho}]} + \frac{\beta\ L^{-\rho}}{[\alpha K^{-\rho} + \beta L^{-\rho}]}\right] \tag{14a}$$

Simplifying equation (14a), we shall get

$$K\ \frac{\partial Q}{\partial K} + L\ \frac{\partial Q}{\partial L} = \mu Q$$

3. The elasticity of substitution for a CES production function is given by $\sigma = \frac{1}{1+\rho}$

Proof:

$$\text{Elasticity of Substitution } (\sigma) = \frac{\text{proportionate change in } (\frac{K}{L})}{\text{Proportionate change in factor price ratio}} \tag{15a}$$

Factor price ratio is equal to the marginal rate of technical substitution of capital for labour. So we can rewrite equation (15a) as,

$$\text{Elasticity of Substitution } (\sigma) = \frac{\text{proportionate change in } (\frac{K}{L})}{\text{Proportionate change in } \mathrm{MRTS_{LK}}} \tag{16a}$$

Again $MRTS_{LK}$ is the ratio of marginal products of the factors.

So $$MRTS_{LK} = \frac{MP_L}{MP_K}$$

So equation (16a) can be expressed as,

$$\text{Elasticity of Substitution } (\sigma) = \frac{\partial\left(\frac{K}{L}\right)}{\left(\frac{K}{L}\right)} \Bigg/ \frac{\partial\left(\frac{MP_L}{MP_K}\right)}{\left(\frac{MP_L}{MP_K}\right)} \tag{17a}$$

Substituting the values of MP_L and MP_K from property 2 in equation (17a), then we will get

$$\text{Elasticity of Substitution } (\sigma) = \frac{\partial\left(\frac{K}{L}\right)}{\left(\frac{K}{L}\right)} \Bigg/ \frac{\partial\left(\frac{\mu \frac{Q}{[\alpha K^{-\rho} + \beta L^{-\rho}]} \beta L^{-(1+\rho)}}{\mu \frac{Q}{[\alpha K^{-\rho} + \beta L^{-\rho}]} \alpha K^{-(1+\rho)}}\right)}{\left(\frac{\mu \frac{Q}{[\alpha K^{-\rho} + \beta L^{-\rho}]} \beta L^{-(1+\rho)}}{\mu \frac{Q}{[\alpha K^{-\rho} + \beta L^{-\rho}]} \alpha K^{-(1+\rho)}}\right)} \quad (18a)$$

Expanding equation (18a),

$$\text{Elasticity of Substitution } (\sigma) = \frac{\partial\left(\frac{K}{L}\right)}{\left(\frac{K}{L}\right)} \Bigg/ \frac{\partial\left(\frac{\beta}{\alpha}\left(\frac{K}{L}\right)^{1+\rho}\right)}{\left(\frac{\beta}{\alpha}\left(\frac{K}{L}\right)^{1+\rho}\right)}$$

Further

$$\text{Elasticity of Substitution } (\sigma) = \left(\frac{K}{L}\right)^{\rho} \Bigg/ \frac{1}{(1+\rho)\left(\frac{K}{L}\right)^{\rho}} = \frac{1}{1+\rho}$$

4. The C-D production function is a limiting case of CES production function.

Proof:

When ρ tends to 0 and σ approaches 1, the CES production function approaches the C-D production function.

$$Q = A\,[\alpha K^{-\rho} + \beta L^{-\rho}]^{-\mu/\rho} \quad (19a)$$

Taking ‘A’ to the left hand side of equation (19a),

$$\frac{Q}{A} = [\alpha K^{-\rho} + \beta L^{-\rho}]^{-\mu/\rho} \quad (20a)$$

Taking logarithm both the side of equation (20a),

$$log\left(\frac{Q}{A}\right) = log\,[\alpha K^{-\rho} + \beta L^{-\rho}]^{-\mu/\rho} \quad (21a)$$

Expanding equation (21a),

$$log\left(\frac{Q}{A}\right) = \frac{-\mu}{\rho}\log\,[\alpha K^{-\rho} + \beta L^{-\rho}] \quad (22a)$$

By L’ Hospital’s Rule,

$$\lim_{\rho\to 0}\left[log\left(\frac{Q}{A}\right)\right] = \lim_{\rho\to 0} \mu \frac{\frac{d}{d\rho}\{-\log\,[\alpha K^{-\rho} + \beta L^{-\rho}]\}}{\frac{d}{dA}(A)} \quad (23a)$$

Solving equation (23a), we will get

$$\lim_{\rho\to 0}\left[log\left(\frac{Q}{A}\right)\right] = \alpha \log K + \beta \log L \quad (24a)$$

Further,

$$\lim_{\rho\to 0}\left[log\left(\frac{Q}{A}\right)\right] = \log(K^{\alpha}L^{\beta}) \quad (25a)$$

Further simplifying,

$$\lim_{\rho\to 0} Q = \lim_{\rho\to 0}\left[Ae^{log\left(\frac{Q}{A}\right)}\right] \quad (26a)$$

Putting the limiting value both the side of equation (26a),

$$Q = Ae^{\log(K^{\alpha}L^{\beta})} = A\,K^{\alpha}L^{\beta} \quad (27a)$$

This proves CES production function approaches C-D Production function when $\rho \to 0$.

A3.3 Trends of labour compensation and profit

The labour compensation is the part of net value added owes to labour. The rest of NVA is the profit. The variables used in the analysis are taken from Socio Economic Accounts for India by WIOD. Labour Compensation (LAB) and Capital Compensation (CAP) are taken as proxies for payment of labour use and profit. The share distribution of labour compensation and capital compensation comes out like a mirror image as they both add up to 100. (For details see Section 1.4, Chapter 1)

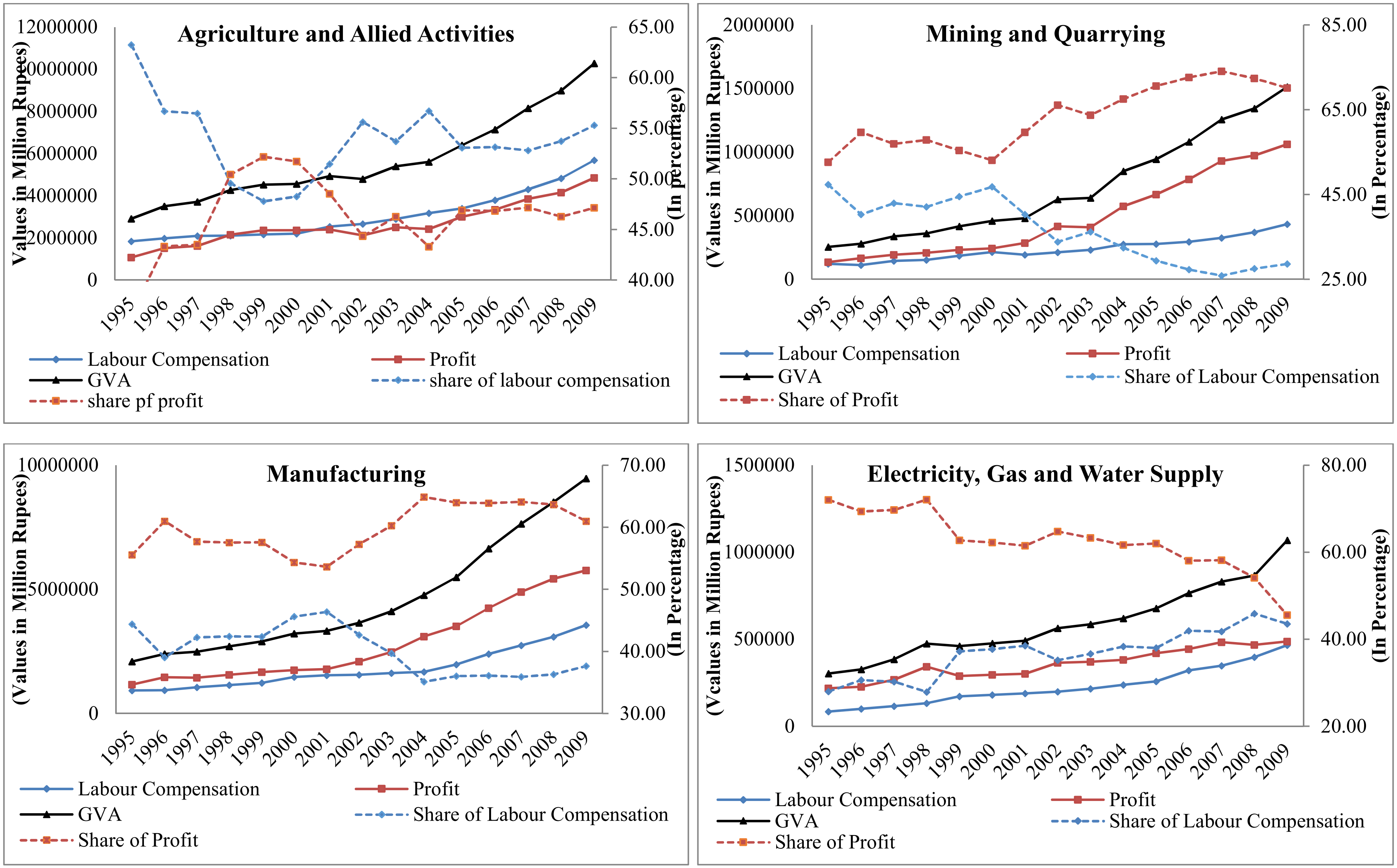
The trend of Labour Compensation, Profit and GVA suggests increase all three variables over the period 1995 to 2009. The labour compensation for Agriculture and allied activities, Construction and Services is greater than the profit. The divergence between labour compensation and profit is increasing in the Mining and Quarrying, Manufacturing and Construction sectors.

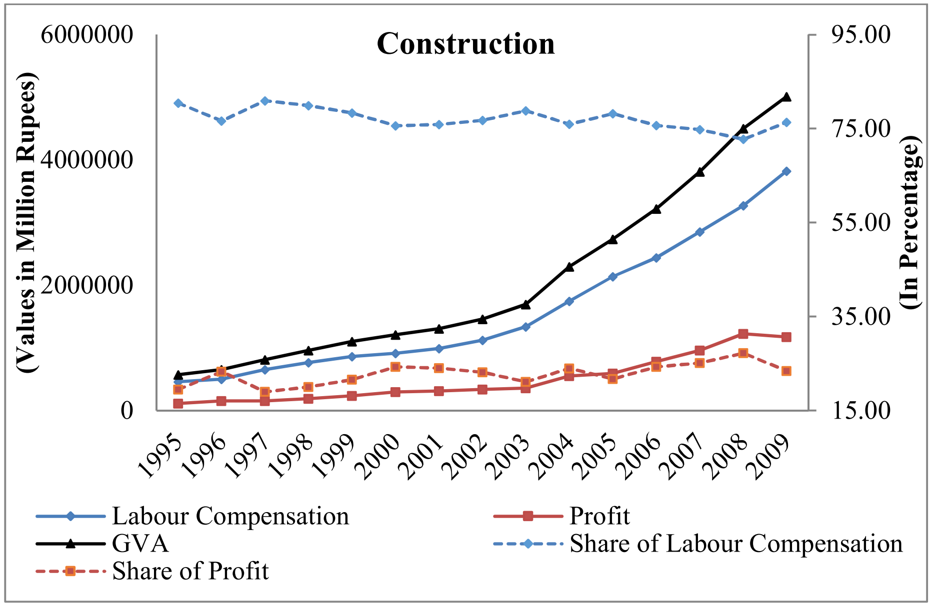
For the agricultural & allied activities, the share of labour compensation in GVA was 63% in the year 1995 which has declined to 55% in 2009. The fall in the share is very high during late 90s' but after that it had increased. The share of capital follows just the opposite trend. Its share was 37% in 1995 which has increased to 45% in this sector. The sharp increase in the share of profit during the period 1998 to 2001 is because of the rise in the profit. Though GVA and labour compensation have followed the similar trend, there is a surge in the profit. During the period 2005 to 2009 the divergence between labour compensation and profit increases. This resulted in increase in share of profit in GVA.

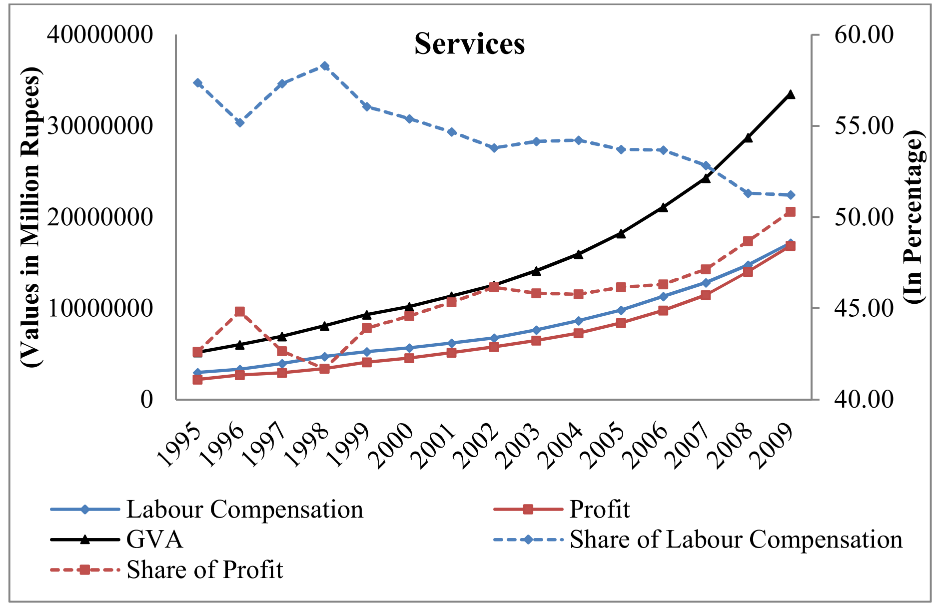
The share of labour compensation of the manufacturing sector in value added was 44% in 1995 which has further declined to 38% in 2009. The trend of GVA, Labour compensation and Profit shows an increasing divergence between profit and labour compensation. Much of the increase in the value added is diverted towards the payment for the use of capital. The declining share of labour compensation and increasing share of profit reflects the increasing gap between the two. This reflects the increased capitalization of the production activities in the manufacturing sector. The share of labour compensation was more than fifty percent in case of Textile, Leather, Wood product, Manufacturing nec. and Recycling. These sectors are more labour intensive sectors. In the other labour intensive manufacturing like Food processing, Paper product, Non-metallic mineral product, the share of labour compensation has increased but they are not greater than half of the value added. For other sectors the share of labour compensation is quite low. It is lowest in the Rubber, Plastic and Petroleum product.

The trends in the mining sector also follow the same as the manufacturing sector. For the services sector, the GVA shows a increasing trend so are the labour compensation and profit. The trend reflects a converging gap between the labour compensation and profit. The decreasing gap between the two gets reflected in the declining gap between the share of labour compensation and share of profit in value added. The share of labour compensation in value added in services was 57% in 1995 which has further declined to 51% in 2009.

Fig. A3.1: Distribution of GVA between Labour Compensation and Profit (Both in Absolute and Share terms)







Source: Calculated from Socio-economic accounts published by WIOD.

Note: All values are in current prices.

The Share of Labour Compensation and Share of Profit in GVA are dashed line. They pertain to the secondary vertical axis.

In the construction sector the GVA increased in a secular tendency. Much of the increased valued added is diverted towards labour compensation. The rise in the labour compensation is almost same as the rise in the GVA in this sector while there is mild rise in the profit. The divergence between labour compensation and Profit is increasing in the study period. High gap in the share of labour compensation and share of capital in value added is due to the gap in the factor distribution. The share of labour compensation in the construction sector is very high. It was 80% in 1995 which has slightly declined to 76% in 2009. The share of labour compensation in the Electricity, Gas and Water Supply, has increased from 28% in 1995 to 44% in 2009 and there is also a corresponding fall in the share of profit. The trend of profit and labour compensation suggests in this sector profit is much higher than the labour compensation. But the divergence between the two declines over the period. The increase in the value added is diverted much towards the labour compensation.

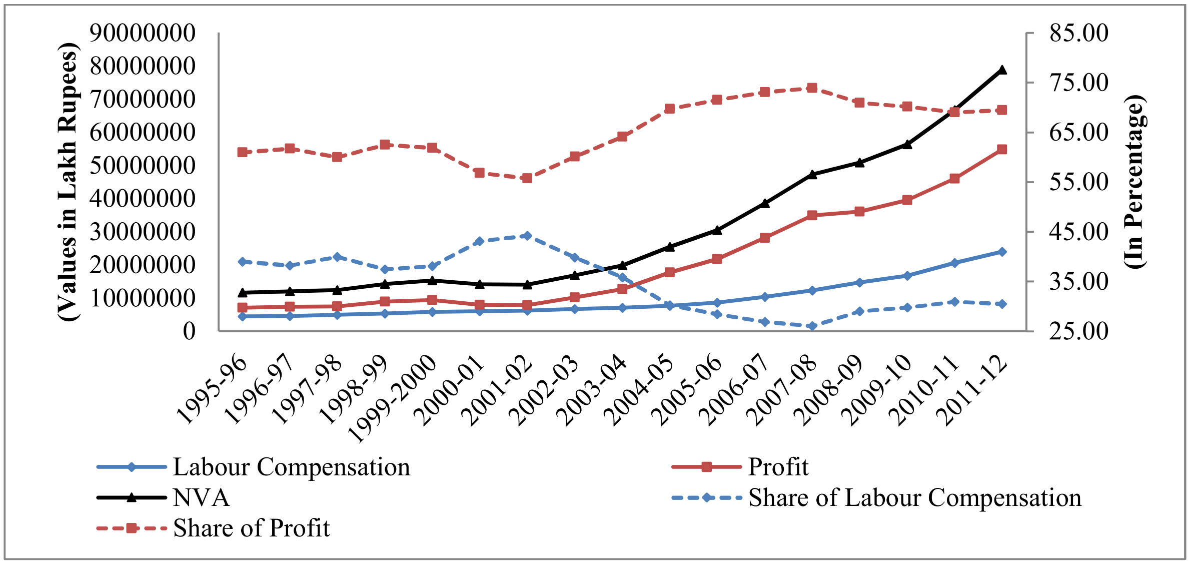
A3.4 Trends of labour compensation and profit in registered manufacturing

Annual Survey of Industries (ASI) is the data source for the variables used in the analysis in this section. Labour compensation and Profit (with rent and interest paid) are used. These two variables add up to Net Value Added (NVA). Rate of profit is the ratio of Profit (with rent and interest paid) to fixed capital. (For details see Section 1.4, Chapter 1)

Fig. 6.2 gives a picture of trends of labour compensation, Profit and Net Value added. Net valued added has an increasing trend. And the same trend is followed by profit. Labour compensation in the registered manufacturing has increased in the period of study. But the increase is quite stable in comparison to profit and net value added. The trends also suggest increasing gap between profit and labour compensation.

From the Annual Survey of Industries (ASI), the real labour compensation per person engaged was compiled. For the Registered Manufacturing the figure was 0.719 lakh rupees per person engaged in the year 1995-96 which increased to 0.89 lakh rupees per person engaged. The high wage sectors are Rubber plastic and petroleum product, Chemical product, Basic and non-ferrous metal product, Electrical and optical equipment, Transport equipment. In the previous chapters, high level of productivity is also found in these sectors. These sectors are basically the capital intensive sectors.

Fig. A3.2: Distribution of NVA between Labour Compensation and Profit in Registered Manufacturing (Both in Absolute and Share terms)



Source: Calculated from Annual Survey of Industries.

Note: Values are in current prices. The share of Labour compensation and share of Profit in NVA are presented in dashed lines and they pertain to the secondary vertical axis.

The distribution of Net value added (NVA) into labour compensation and profit for the registered manufacturing as a whole is presented in Fig. A3.2. It is clear from the figure that the share of profit in NVA was around 60% in 1995-96 which increased to 69.5% in 2011-12. The share of labour compensation in NVA is just the mirror image of the share of profit and the trend of this share is found to be declining during the period of the study from 1995-96 to 2011-12. In the sectors like Textile product, Leather product and Paper product and Manufacturing nec and recycling the share of labour compensation had increased from 1995-96 to 2011-12. The shares are almost stagnant in the Chemical product, Non-metallic mineral product, and electrical and optical equipment. In other sectors there is a sharp decline in the share of labour compensation.

Alternative Approach to Measurement of Productivity-I (Direct Labour Productivity)

4.1 Introduction

The theoretical background and assumptions in the conventional approaches as well as the empirical estimates, in the previous two chapters, look at the problem of productivity growth as only a growth in the Total Factor Productivity. These approaches do not make a strict reference to the *causes* of growth. This calls for an alternative approach looking at productivity from the perspective of growth but not from a perspective of distribution. A distinct approach can be located in the classical economics of Adam Smith. Unhindered by theoretical and methodological difficulties, this approach places the problem of productivity of labour at the centre of economic growth and accumulation. The present chapter tries to situate the very problem of productivity at the centre of growth, the relevant concept of productivity here being ‘Labour Productivity’.

> The greatest improvement in the productive powers of labour, and the greater part of the skill, dexterity, and judgement with which it is anywhere directed, or applied, seen to have been the effects of the division of labour.(Smith, 1776: 13)

The first paragraph of the magnum opus is directed to describe the causes of productivity increase. In fact, the productivity of labour and growth are bound together in a circular and cumulative process of change. There is no logical separation of labour from non-labour means of production or technical change. By lending transparency to the forces promoting or limiting productivity, the classical approach affords a better guide for policy.

Section 4.2 gives an introduction to the problem of labour productivity and constitutes a theoretical build up to the problem. Section 4.3 is devoted towards the analysis of trends and growth of productivity in different sectors. Section 4.4 continues the analysis of productivity, particularly for the registered manufacturing sectors. Section 4.5 gives an account of sources of growth. Section 4.6 looks into the structural transformation through linkage index which sets up the background for chapter 5. Section 4.7 deals with the impact of international trade on employment and productivity. This is followed by brief concluding section. The data used in the chapter is collected from National Accounts Statistics, National Sample Survey on Employment and Annual Survey of Industries (Details of the database used is presented in the Appendix to the chapter). From the discussions in the chapter, it will be found that the overall productivity during the study period has increased for all the sectors. But the real concern was the divergence in the rate of growth in the labour productivity of organised and unorganised sectors. Productivity in the unorganised sector lagged behind that of the organised sector. The unorganised sector supports around 93% of the total employment in the year 2011-12. The large employment base of the unorganised sector may be causing a slow productivity growth. Again the labour productivity of the registered manufacturing increased during the study period, and the productivity growth is well-explained by the Verdoorn's law and Kaldor's technological progress function. The manufacturing factories with the large scale of production have done fairly well. Within registered manufacturing, corporate sector manufacturing also performed well during the period of study.

4.2 Concept of 'Direct Labour Productivity'

The most common measure of labour productivity in an industry is provided by dividing some measure of output by employment. Direct labour productivity can be stated as sectoral productivity also. It is called direct as it considers only the employment of the sector itself. The sectoral dependency is not taken into account either in the process of production or in employment.

Smith brought 'division of labour' to the centre stage to explain the factors that determine the standard of living. By standard of living, Smith referred to the per capita income in modern economic language. The level of national income is the multiple of productivity and number of labour employed.

$$Y = \pi L \tag{1}$$

Dividing both the sides the equation by the population (N),

$$\frac{Y}{N} = \pi \frac{L}{N} \tag{2}$$

Equation (2) shows per capita income is the multiplication of average product of worker and the proportion of labour in the total population.The classical economists before Smith argued agriculture as the only sector producing a surplus which is to be reinvested. But it was Smith who believed industry also produced surplus and therefore contributed to growth. The simple decomposition of per head output growth into employment growth and productivity growth solves the problem of explaining the growth process. While the productivity growth is the prime factor in the determination of the per head output growth, the employment growth depends upon the structure of the production process and the use of type of capital. In the literature of economics, the explanation for the growth of labour productivity has acquired a significant place. Smith (1776) in his explanation argued that the cause behind the labour productivity growth is the division of labour.[1]

> The great increase of the quantity of work, which in consequence of the division of labour, the same number of people are capable of performing, is owing to three different circumstances; first, to the increase of the dexterity in every particular workman; secondly, to the saving of the time which is commonly lost in passing from one species of work to another; and lastly, to the invention of a great number of machines which facilitate and abridge labour, and enable one man to do the work of many. (Smith, 1776: 17)

The simplification of production procedure by splitting down the whole activity into several simple activities will enhance the average product of the labour. Later, the cumulative causation theorists (Young, 1928; Kaldor, 1957) have added another dimension, of the division of labour, for their analysis. Division of labour is not just the change in the occupational structure of the economy, but it is also the explanation of the operation of the scale economies.

Labour productivity depends on the stage reached by the division of labour. There are two basic relationships in Smith's growth theory; one, positive effect of division of labour on productivity which he explains by the famous pin factory example; and two, between the growth of market and the degree of division of labour. To absorb the produce from the greater productivity and increase in employment, the market has to grow in a similar proportion. So to realise the entire potential of division of labour the size of market constitutes the primary constraint.

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[1] Adam Smith in his 'Wealth of Nations' has attributed the productivity growth to the increased division of labour. He further explained that division of labour is limited by the extent of market. This view was later taken up by Kaldor in his cumulative causation theory.

For details see Smith (1776: Book 1, Chap. 3, 31), Toner (1965: Chap. 7).

The connection between the ‘extent of market’ and ‘division of labour’ is often misrepresented by the neoclassical economists through U-shaped cost curve, but they are predominantly static in nature while Smith conceptualised these two in a continuous time space as a process. There are three aspects of division of labour; one, microeconomic division of labour i.e. division of labour within and individual productive unit; second, social division of labour i.e. among different jobs and professions; and third, macroeconomic division of labour i.e. among firms and sectors producing different commodities.

Pre-Smithian classical economists classified agricultural worker and farmers, artisans, nobility and clergy in a transition society from feudalism to capitalism whereas Smith classification is based on capitalistic economy. In a capitalistic economy, the difference in the bargaining power between capitalist and workers gives rise to surplus. A surplus is that part of produce which is left over after reconstitution of primary inventories of means of production and means of subsistence for workers engaged in production process. The economy as a system works in a cumulative circular way to reconstitute the means of production and generate surplus.

The process of accumulation of surplus induces investments in new means of production and also increases employment and therefore the proportion of wages in the surplus. The process of accumulation needs to differentiate between productive labour and unproductive labour. Smith defined a productive labour as that labour which adds to physical goods or generates profit, or the wage is being drawn from the use of capital, not from the master.

The equation (2) defines per capita income as a multiple of Labour productivity and share of productive workers. The share of productive workers depends on the stage reached by the process of accumulation. The process of accumulation treats labour and means of production as complementary in contrast to the neoclassical production theory. The stage of accumulation shows the amount of capital available to give work to the new productive worker.

Arrow’s ‘learning by doing’ is the nearest explanation in the modern growth theories in line with that of Smith’s. The strong interconnection between investment and growth is a cumulative circular process in classical growth theories. A typical neoclassical growth theory will presume the economy is in a state of equilibrium and any force that displaces the economy from the original position will meet with an opposite force. This will restore the economy back to a position of equilibrium. The theories are necessarily consistent with a static economy which has scarcity of resources. But for the classical economists, Growth means generation of new means of production.

The rate of accumulation and growth depends on distribution of surplus among different social class and on the channel in which the surplus is being put to use. The three classes that formed the society are the Landlord, Capitalists and the Workers. Capitalists are concerned with the prospects of accumulation. The size of accumulation depends on the demand for the produce which needs the purchasing power of the working class has to increase. So larger the share of labour compensation more will be the generation of surplus through accumulation, and more will be the profit for the capitalist class. Thus the vicious circle of accumulation will ensure higher factor payment for the workers for their improvement in the productivity. The cumulative causation of division of labour, labour productivity, returns to scale, accumulation of surplus, generation of means of production and increase in the social purchasing power through improvement increase in wage bill added together lead to spiral functioning of the economic system.

The experience of capitalist development across economies suggests a transformation of the structure of the economy. The transformation means the changes in the composition of production and employment. The rising share of non-farm activity is associated with the rising standard of living. The rise in the labour productivity in agricultural sector enables the shift in labour to non-farm sectors. While the growth in labour productivity in Agriculture fuels the growth in non-agricultural sector, the process is related in a circular and cumulative way. The role of agriculture in the process of growth is not passive, but the rise in agricultural productivity brings about the expansion demand for non-agricultural product. The market constituted by the expansion of agriculture paves the way for changing manufacturing production.[2]Kaldor has propounded three stylised facts regarding manufacturing sector. Firstly, Manufacturing is the engine of growth. Secondly, Manufacturing growth induces productivity growth in manufacturing through returns to scale. Lastly, manufacturing growth induces productivity growth outside manufacturing but absorbing low productive labour and thus economic growth is

[2] Kuznets (1966: 9).

positively related to manufacturing employment and negatively related to non-manufacturing employment. The growth of manufacturing depends upon the demand from agriculture in the early stages of development.[3]

4.3 Trends in output and productivity

The development story of India has its strengths and lacuna. During the last three decades, the NDP growth has been quite spectacular, but it is not reflected when employment generation is taken into account. After the implementation of the liberalisation policy, the economy has suddenly shifted to service sector domination. This major shift is a sharp contrast to the process of capitalist development of the western economies.[4] The service sector-led growth has not been able to absorb the unskilled labour even if the migration of labour from farm sector to non-farm sector has been very slow. The potential absorber of the unskilled labour force is manufacturing, and in the liberalisation period, the growth of this sector has been high however its contribution to NDP remains very low. Still, a large section of the population depends on Agriculture and Allied activities.

The expansion of employment to population ratio is one side of the growth of the economy. The increase in employment helps in creating the demand, and it involves directly in improving the standard of living of the population. So the labour market situations are essential for the implementation of economic policy. The increase in job and the quality of job describe much about the well-being of the population. The process of economic transformation is expected to bring about new jobs as well as the migration of labour from the primary sectors to tertiary sectors. The manufacturing sector lacks in absorbing the unskilled labour force. The more and more use of capital intensive technique led to a situation of jobless growth in the manufacturing sector. The service sector has been applying the roundabout technology, as the expected employment generation in this sector is low. Therefore, agriculture and allied activities are the major employment providing sector in spite of a decreasing share in economy's NDP.

In fact, researchers found it problematic when they deal with measurement of labour. The vast and diverse pattern of employment in India in different economic sectors made the concept

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[3]Kaldor (1996: 176).

[4] See Kuznets (1973: 248), Chenery (1960: 416), Chenery and Taylor (1968: 395).

of labour very complicated. As the Indian economy is predominantly agrarian, the formation of the labour market is a case of interaction between households which aims at making a subsistence level of consumption for survival and the households and enterprises which seek surplus. The mutually interdependent structure of rural and industrial employment cannot be isolated from each other. Much of the Indian households are either petty producers or landless labour or have very small land holdings. A large section of labour is family labour with low productivity which constrains the formation of the labour market. Also, women and children of a household can work on their own land, but they are reluctant to work in others' as hired labours.

There is prevalence of various kind of system of employment in rural areas. Some of the hired labours are ‘permanent’ and ‘causal' labour with different work conditions for both. There is also existence of non-wage labour which varies from caste and villages. Adding to this, a predominantly domestic work by the female members complicates the conceptualisation of labour and its classification (See Bharadwaj, 1994)[5]. Characteristically, Indian workforce has two distinct features; one, a dominant share of agricultural labour force with seasonal variation, and two, a very small share of regular wage/salary workers. So to measure and conceptualise employment at least a year has to be taken as the reference year (Dantwala Report, 1969). The recommendation of the expert group prompted NSSO to conceptualise employment in four statuses; (1) Usual Principal Status, (2) Usual Principal and Subsidiary Status, (3) Current Weekly Status, (4) Current Daily Status.[6]

1. Usual Principal Status (UPS): A person is counted as being in the labour force on principal usual activity basis if s/he was either engaged in economic activity (work) or reported seeking/being available for work for the major part of the preceding 365 days. Those classified as being in the labour force on this basis are further classified as being employed or unemployed depending on whether the majority of the days in labour force was spent in economic activity or in seeking/being available for work. The Usual Principal Status unemployment rate is the proportion of those classified as unemployed on this basis expressed as a percentage of those classified as being in the labour force. On this criterion, persons can be counted as being

[5] See Bharadwaj (1994: 336)

[6]See NSSO Report on Employment and Unemployment different rounds.

employed even if they were unemployed (or were outside the labour force) for a significant part of the year. Equally, a person can be counted as unemployed even though s/he may have been employed for part of the year.

2. Usual Principal and Subsidiary Status (UPSS): This provides a more inclusive measure covering, also, the participation in economic activity on a more or less regular basis of those classified as unemployed on the Usual Principal Status as also of those classified as being outside the labour force on the same criterion. This would result in a larger proportion of the population as being in the labour force with a higher proportion of workers and lower unemployment rates relative to the UPS criterion.

3. Current Weekly Status (CWS): The reference period here is the week i.e. the seven days preceding the interview. A person is counted as employed if s/he was engaged in economic activity for at least one hour on any day during the reference week. A person not being engaged in economic activity even for one hour on any day but reporting seeking/being available for work during the reference week is classified as unemployed. To the extent that employment varies seasonally over the year, the labour force participation rates on the Current Weekly Status would tend to be lower. However, reflecting the unemployment during the current week of those classified as being employed by the UPS (and the UPSS) criterion, the Current Weekly Status unemployment rates would tend to be higher. The difference between the unemployment rates on the Current Weekly and that on the Usual Status would provide one measure of seasonal unemployment.

4. Current Daily Status (CDS): Based on the reported time disposition of the person on each day of the reference week (in units of half day where needed by the presence of multiple activities within a day), person-days in employment (unemployment) are aggregated to generate estimates of person-days in employment/unemployment. The person-day unemployment rate is derived as the ratio of person-days in unemployment to the person-days in the labour force (i.e. person-days in employment plus person-days in unemployment). This measure captures the ‘within-week’ unemployment of those classifies as employed on the Weekly Status. The CDS-measure of unemployment is widely agreed to be the one that most fully captures open unemployment in the country.

This section will examine the trends and growth of productivity which takes into accounts both NDP_{FC} and employment in the overall economy as well as broad sector-wise. But before that, a brief view of Employment and NDP_{FC} is presented in Table 4.1.

Table 4.1: Brief Picture of Indian Economy in 2004-05[7]

	Rural	Urban	Organised	Unorganised	Total
NDP_{FC} (In Crore Rupees)	1276485	1375088	1090018	1561556	2651573
Share In NDP_{FC} (in Percentage)	48.14	51.86	41.11	58.89	100.00
Employment (in Lakhs)	3178.168	908.44	264.59	3821.96	4086.55
Share in Employment (in Percentage)	77.77	22.23	6.47	93.53	100.00

Source: Calculated from NAS, CSO and NSSO rounds on employment and unemployment situation in India.

1. For NDP_{FC}: NAS, Back Series 2011, Statement 7, p. 29
2. For Organised and Unorganised NDP_{FC}: NAS, 2007, Statement 76.1, p. 180;
3. For Rural and Urban NDP_{FC}: National Accounts Statistics: Sources and Methods, 2012, Appendix 31.2, p. 314
4. For Employment: NSSO 61st Round, Employment and Unemployment Situation in India, Report No. 515, Table 28
5. For Organised Employment, source is Directorate General of Employment and Training. The data is also available in Economic Survey.

Note: Values of NDP_{FC} is at current prices

The estimates from National Accounts Statistics show 58.89% of the NDP_{FC} is from unorganised sectors. The organised sectors in India only constitute 41.11% of $NDP_{FC.}$ The situation is even worse in case of employment as 93.53 % of the employment works in the unorganised sectors. Agriculture constitutes the major employment proportion within the unorganised sector. As Agriculture is considered to constitute the Rural economy, a rural- urban break up is necessary for the clear picture. The Rural India contributes 48.14% of its NDP_{FC} where as its contribution towards employment is 77.77% of the total employment.

[7] Year 2004-05 is the latest year for which the Rural-Urban Break up of NDP_{FC} is available.

4.3.1 Trends of productivity

Table 4.2 gives the figures for National level for different years.[8] These figures have also been broken up into organised and unorganised sector. The table gives a broad sense of the trends in the different strategic variables. From the Table, it could be seen that the NDP increased during the period 1983-84 to 2011-12. It was Rs 184217crores in the year 1983-84 and increased to Rs 7511796 crores. The employment grew but not as fast as the NDP growth. The labour productivity figure also increased from Rs 60.53 hundreds to Rs 1786.25 hundreds. The trend in capital intensity also maintained similar pattern.

For the organised sectors, the labour productivity increased much faster than the unorganised sectors. The ratio of labour productivity of organised to unorganised sector (Table 4.2) gives a clear indication of rapid growth in productivity in organised sector during the period of study from 1983-84 to 2011-12. Figure 4.1 also depicts an increasing gap between the productivity of organised sector and unorganised sector. The gap has increased after 1999-2000. The labour productivity gap between the organised and unorganised sectors is also very high. Though the NDP is lower in the organised sectors than the unorganised sector, the employment in these sectors made a huge difference. The organised sector employment is very low.

Net domestic product grew at 6% per annum during the last two decades. Particularly during the period 2003-08, the growth was as high as 8.5% per annum.[9] India has been among the fastest growing economies, and the rate of capital accumulation also has remained very high. The rest of the world sees India as a place for large potential market and therefore she is a large investment destination after opening up to the world.However, the uneven growth trajectory of the secondary sector has been a cause of concern throughout the period.

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[8]Years are chosen on the basis of availability of Employment data by NSSO.

[9] Panda (2013: 16).

Table 4.2: Strategic Variables

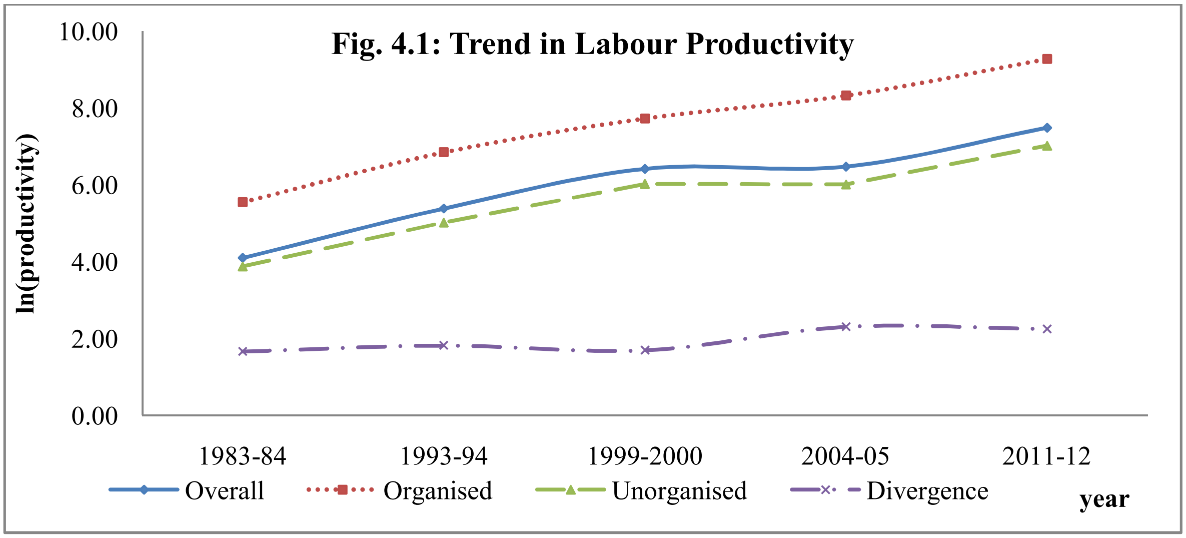
Variables	1983-84	1993-94	1999-2000	2004-05	2011-12
Overall					
NDP_{FC}(in Crores Rupees)	184217	711268	1605104	2651573	7511796
Employment (in Lakhs)	3043.16	3257.34	2621.33	4086.55	4205.35
Net Capital Stock (in Crores Rupees)	3001855	4904834	6891842	9325629	17790201
Labour Productivity (in Hundreds Rupees per worker)	60.53	218.36	612.32	648.85	1786.25
Capital Intensity (in Hundreds Rupees per worker)[10]	986.43	1505.78	2629.14	2282.03	4230.37
Organised					
NDP_{FC}(in Crores Rupees)	62314	257831	634767	1090018	3124836
Employment (in Lakhs)	242.05	273.75	279.60	264.59	292.70
Labour Productivity (in Hundreds Rupees per worker)	257.44	941.85	2270.27	4119.65	10675.90
Unorganised					
NDP_{FC}(in Crores Rupees)	121903	453437	970337	1561556	4386960
Employment(in Lakhs)	2801.11	2983.59	2341.73	3821.96	3912.65
Labour Productivity (in Hundreds Rupees per worker)	48.52	151.98	414.37	408.57	1121.22
Ratio of productivities (Organised/Unorganised)	5.31	6.19	5.48	10.08	9.52

Source: Calculated from NAS, CSO and NSSO rounds on employment and unemployment situation in India.

1. For NDP_{FC}: NAS, Back Series 2011, Statement 7, p. 29; and NAS, 2014, Statement 12 p. 21.
2. For Organised and Unorganised NDP: NAS, 2008, Factor Incomes (1980-81 – 1999-2000), Statement 3.1 and 4.1; NAS, 2007, Statement 76.1, p. 180; NAS, 2014, Statement 76.1, p. 206.
3. For Employment: NSSO 38th Round, Employment and Unemployment in India,1983-84; NSSO 50th Round, Employment and Unemployment in India,1993-94, Report No 409, Table No. 6.7.1 and 6.7.2; NSSO 61st Round, Employment and Unemployment Situation in India, Report No. 515, Table 28; NSSO 68th Round, Employment and Unemployment Situation in India, Report No. 554, Table P8.
4. For Organised Employment, source is Directorate General of Employment and Training. The data is also available in Economic Survey.
5. For Net Capital Stock: NAS, Back Series 2011, Statement 17, p. 154; and NAS, 2014, Statement 22, p. 54.

Deflator used: GDP Deflator at 2004-05 prices.

[10]Capital intensity is Net Capital Stock per employment. The values for capital intensity for the organised and unorganised sector could not be calculated as the data for Net Capital Stock for the organised and unorganised division is not available.



Source: Calculated from NAS, CSO and NSSO rounds on employment and unemployment situation in India.

1. For NDP_{FC}: NAS, Back Series 2011, Statement 7, p. 29; and NAS, 2014, Statement 12 p. 21.
2. For Organised and Unorganised NDP: NAS, 2008, Factor Incomes (1980-81 – 1999-2000), Statement 3.1 and 4.1; NAS, 2007, Statement 76.1, p. 180; NAS, 2014, Statement 76.1, p. 206.
3. For Employment: NSSO 38th Round, Employment and Unemployment in India,1983-84; NSSO 50th Round, Employment and Unemployment in India,1993-94, Report No 409, Table No. 6.7.1 and 6.7.2; NSSO 61st Round, Employment and Unemployment Situation in India, Report No. 515, Table 28; NSSO 68th Round, Employment and Unemployment Situation in India, Report No 554, Table P8.
4. For Organised Employment, source is Directorate General of Employment and Training. The data is also available in Economic Survey.

Deflator used: GDP Deflator at 2004-05 prices.

Expansionary fiscal policy and slow implementation of liberalisation policy during the 1980's have proved pivotal in the surge of growth rate in the Indian economy. The growth rate was 4.86% per annum for the period 1983-84 to 1993-94. The growth rate before that phase was 3 to 4%. After the initiation of liberalisation policy in 1980-81, the economy grew at 6.41% per annum in the period 1983-84 to 1993-94. After the implementation of LPG policy in the 1990-91, the economy grew very fast. In the first half of the implementation of the policy, the growth rate was 6.52%, and it had increased to 8.51% per annum during the second half from 2004-05 to 2011-12. One of the striking points in this growth had been a steady and less deviated increase in the NDP. Before the 80's much of the economy was dependent on the agriculture, and this sector particularly was a gamble of Monsoon. A bad monsoon hit not only the agriculture but also the agro-based industries. So there had been high fluctuation in the pre-80. But, thanks to the changes in the structure of the economy, the fluctuations in annual growth have been controlled. A division of economy into organised and unorganised sectors gives a different picture. In the post liberalisation period, the organised sectors have benefitted more than the unorganised ones.

Table 4.3: Labour Productivity Growth (Overall) (in Percentage)

Periods[11]	Agriculture and Allied Activities	Mining	Manufacturing	Electricity, gas and water supply	Construction	Services	Total
			Growth in NDP_{FC}				
1983-84 to 2011-12	2.99	4.80	6.38	6.88	7.19	8.17	6.41
1983-84 to 1993-94	2.69	5.05	4.39	8.83	4.98	6.78	4.86
1993-94 to 2011-12	3.15	4.66	7.50	5.81	8.43	8.95	7.29
			Growth in Employment				
1983-84 to 2011-12	0.01	0.05	2.00	-6.47	13.46	2.86	1.16
1983-84 to 1993-94	0.33	0.53	1.12	-8.09	13.84	2.67	0.68
1993-94 to 2011-12	-0.16	-0.22	2.50	-5.56	13.25	2.96	1.43
			Growth in Labour Productivity				
1983-84 to 2011-12	2.97	4.75	4.29	14.28	-5.53	5.16	5.19
1983-84 to 1993-94	2.35	4.49	3.23	18.41	-7.79	3.99	4.15
1993-94 to 2011-12	3.32	4.89	4.88	12.04	-4.26	5.82	5.78
			Residual				
1983-84 to 2011-12	0.00	0.00	0.09	-0.92	-0.74	0.15	0.06
1983-84 to 1993-94	0.01	0.02	0.04	-1.49	-1.08	0.11	0.03
1993-94 to 2011-12	-0.01	-0.01	0.12	-0.67	-0.56	0.17	0.08

Source: Calculated from NAS, CSO and NSSO rounds on employment and unemployment situation in India.

1. For NDP_{FC}: NAS, Back Series 2011, Statement 7, p. 29; and NAS, 2014, Statement 12 p. 21.
2. For Employment: NSSO 38th Round, Employment and Unemployment in India,1983-84; NSSO 50th Round, Employment and Unemployment in India,1993-94, Report No 409, Table No. 6.7.1 and 6.7.2; NSSO 61st Round, Employment and Unemployment Situation in India, Report No. 515, Table 28; NSSO 68th Round, Employment and Unemployment Situation in India, Report No 554, Table P8.

Deflator use: GDP Deflator at 2004-05 prices.

Note:

1. Splicing method is applied to get all data at constant prices at the base year 2004-05. All figures in the series of NDP are NDP at factor cost at 2004-05 prices.
2. $Growthrate^{12} = [\{(endvalue/initialvalue)^{\frac{1}{n-1}}\} - 1] * 100$

[11] For the study period from 1983-84 to 2011-12, the years selected are according to the data availability of employment according to the NSSO survey. The division of sub-periods follows according to the implementation of liberalisation policy. The period 1983-84 to 1993-94 is taken as pre-liberalisation period and from 1993-94 to 2011-12 is taken as post liberalisation period.

[12]The growth rate formula used here is of very crude in nature. Because the data is available only for five years during the study period, the use of trend growth rate can't be carried out. So the basic compound annual growth rate is being estimated by the given formula.

Table 4.4: Labour Productivity Growth (Organised) (in Percentage)

Periods[13]	Agriculture and Allied activities	Mining and Quarrying	Man.	Electricity, Gas and Water supply	Construction	Services	Overall
			Growth in NDP				
1983-84 to 2011-12	0.63	4.48	6.63	7.02	5.66	9.00	7.34
1983-84 to 1993-94	-0.43	5.75	5.41	8.48	3.35	7.51	5.56
1993-94 to 2011-12	1.59	4.08	7.05	5.32	7.56	9.79	8.22
1995-96 to 2011-12	2.14	3.95	7.09	5.14	8.10	9.73	8.26
			Growth in Employment				
1983-84 to 2011-12	-0.56	0.48	-2.50	0.10	-1.39	0.18	-0.13
1983-84 to 1993-94	1.16	0.67	0.42	2.61	0.02	1.65	1.42
1993-94 to 2011-12	-0.88	0.96	-3.51	-1.01	-2.22	-0.58	-0.83
1995-96 to 2011-12	-0.85	1.39	-3.53	-1.17	-2.32	-0.71	-0.91
			Growth in Productivity				
1983-84 to 2011-12	1.19	3.98	9.36	6.92	7.15	8.80	7.47
1983-84 to 1993-94	-1.57	5.04	4.97	5.72	3.33	5.77	4.09
1993-94 to 2011-12	2.49	3.09	10.94	6.39	10.00	10.43	9.12
1995-96 to 2011-12	3.01	2.53	11.01	6.39	10.66	10.51	9.26
			Residual				
1983-84 to 2011-12	-0.01	0.02	-0.23	0.01	-0.10	0.02	-0.01
1983-84 to 1993-94	-0.02	0.03	0.02	0.15	0.00	0.09	0.06
1993-94 to 2011-12	-0.02	0.03	-0.38	-0.06	-0.22	-0.06	-0.08
1995-96 to 2011-12	-0.03	0.04	-0.39	-0.07	-0.25	-0.07	-0.08

Source: Calculated from NAS, CSO and DGE & T

1. For Organised NDP: NAS, 2008, Factor Incomes (1980-81 to 1999-2000), Statement 3.1 and 4.1; NAS, 2007, Statement 76.1, p. 180; NAS, 2014, Statement 76.1, p. 206.
2. For Organised Employment, the source is Directorate General of Employment and Training. The data is also available in Economic Survey.

Deflator used: GDP Deflator at 2004-05 prices.

Note:

1. Splicing method is applied to get all data at constant prices at the base year 2004-05. All figures in the series of NDP are NDP at factor cost at 2004-05 prices.
2. The figures are compound growth rates showing the antilogarithms of the relevant regression coefficient minus one when the equations are of the form log Y = a + bT and T refers to time.

[13] In this table a sub-period from 1995-96 to 2011-12 is added. This period is to compare the growth in direct labour productivity and system labour productivity (to be discussed in the next chapter).

Table 4.5: Labour Productivity Growth (Unorganised) (in Percentage)

	Agr. and Allied activities	Mining and Quarryin	Man.	Electricity, Gas and Water supply	Construction	Service	Overall
Growth in NDP							
1983-84 to 2011-12	3.09	8.43	5.34	5.85	8.75	7.74	5.94
1983-84 to 1993-94	2.84	7.29	3.00	0.70	6.71	6.40	4.47
1993-94 to 2011-12	3.23	9.07	6.65	8.82	9.90	8.49	6.77
Growth in Employment							
1983-84 to 2011-12	0.01	-0.48	2.35	-7.99	23.76	3.35	1.20
1983-84 to 1993-94	0.33	0.37	1.30	-9.17	41.24	3.01	0.63
1993-94 to 2011-12	-0.16	-0.94	2.93	-7.33	15.00	3.55	1.52
Growth in Labour Productivity							
1983-84 to 2011-12	3.08	8.95	2.92	15.04	-12.12	4.24	4.68
1983-84 to 1993-94	2.50	6.89	1.68	10.87	-24.45	3.29	3.81
1993-94 to 2011-12	3.40	10.10	3.62	17.43	-4.43	4.78	5.17
Residual							
1983-84 to 2011-12	0.00	-0.04	0.07	-1.20	-2.88	0.14	0.06
1983-84 to 1993-94	0.01	0.03	0.02	-1.00	-10.08	0.10	0.02
1993-94 to 2011-12	-0.01	-0.10	0.11	-1.28	-0.66	0.17	0.08

Source: Calculated from NAS, CSO and NSSO rounds on employment and unemployment situation in India.

1. For Unorganised NDP: NAS, 2008, Factor Incomes (1980-81 – 1999-2000), Statement 3.1 and 4.1; NAS, 2007, Statement 76.1, p. 180; NAS, 2014, Statement 76.1, p. 206.

2. For Employment: NSSO 38th Round, Employment and Unemployment in India,1983-84; NSSO 50th Round, Employment and Unemployment in India,1993-94, Report No 409, Table No. 6.7.1 and 6.7.2; NSSO 61st Round, Employment and Unemployment Situation in India, Report No. 515, Table 28; NSSO 68th Round, Employment and Unemployment Situation in India, Report No 554, Table P8.

   And DGE & T which gives employment for organised sector. So the Unorganised employment is Overall employment minus Organised employment.

Deflator use: GDP Deflator at 2004-05 prices.

Note:

1. Splicing method is applied to get all data at constant prices at the base year 2004-05. All figures in the series of NDP are NDP at factor cost at 2004-05 prices.
2. $Growthrate = [\{(endvalue/initialvalue)^{\frac{1}{n-1}}\} - 1] * 100$

The employment growth in India was rather slow during the entire period of study. The growth rate was 1.16% per annum for the period 1983-84 to 2011-12. The employment growth during the period 1993-94 to 2004-05 was 2.08% which is the peak sub-period of employment generation. In the post-liberalisation period, the employment growth was 1.43% per annum. So the high growth rate of NDP combined with such a low rate of growth in the employment might have given rise to a situation of jobless growth (See Table 4.3). For the organised sector, the employment growth is quite disappointing. The overall organised employment had a negative growth of 0.13% per annum during the period 1984 to 2012. The growth rate has shrunk to 0.11% in the post-reforms period. The employment growth in the unorganised sector was at 1.20% per annum. In the pre-independence period the growth was 0.63% per annum while in between 1993-94 to 2011-12, the employment growth was 1.52% per annum.

Labour productivity in the study period from 1983-84 to 2011-12, grew at 5.19% per annum. The growth took off in the post liberalisation period as it grew at 5.78% per annum in between 1993-94 to 2011-12. In the second half of the liberalisation policy, the growth increased to 8.07% per annum. The growth in the organised sectors was faster during 1983-84 to 2011-12. It grew at 7.47% per annum in comparison to the unorganised sector which grew at 4.68% per annum.

4.3.2 NDP_{FC} growth in different Sectors

During the period of study, the service sector grew rapidly. The growth rate for this sector was 8.17% per annum during the period 1983-84 to 2011-12. In the 80's the growth rate of this sector was 6.78% per annum. In the post liberalisation period, the service sector grew at 8.95% per annum and more particularly in the second decade of the liberalisation policy the growth rate of the sector was as high as 9.73% per annum. The organised service sector grew at 9.00% per annum whereas the growth rate of unorganised service sector was a bit slower (7.74% per annum). Post 90's the growth rate increased at a very rapid rate of 9.79% and 8.49% per annum for organised and unorganised service sector respectively. The growth of organised service sector was 9.98% per annum in the recent years (2004-05 to 2011-12).

Agriculture sector growth had been very slow in the period of study. Though it was dominating the NDP share in the post-independence period, its growth rate declined after the 80's. The growth of the sector was 2.99% per annum during the period 1983-84 to 2011-12. In the post liberalisation period, the growth was recorded 3.15% per annum. The organised agricultural sector grew at 0.63% per annum whereas the unorganised agricultural sector grew at 3.12% per annum. These poor growths meant an increasing divergence between the growth of the whole economy and agricultural sector. This growing gap has negative implications on the inter-sectoral equity. Also the NSS, 2006 reported that around 27% of the farmers were not interested in farming and also approximately 40% of the farmers would leave the occupation if given a choice. Such a poor situation of the Indian agriculture is a matter of grave concern. In the second half of the liberalisation era, there are some signs of revival, and it is due to some corrective measure taken by the government in 2004-05. Government initiatives like Bharat Nirman, RKVY and NFSM, showed their effects. The plan for inclusive growth paid special focus to land management, water management, agricultural marketing and technical improvement. These planned outlays for the agricultural sector are very much necessary to maintain a steady growth.[14]

For a capitalistic development, Manufacturing is treated as an engine of growth. It is the only real sector which operates in the increasing returns unlike the Agriculture and allied activities. The growth of this sector is essential for a steady growth of the economy. The sector had grown at 6.38% per annum during the period of study. In the post-liberalisation period, the manufacturing sector grew at 7.50% per annum and particularly in the second half of the liberalisation period the sectoral growth had been as high as 9.68% per annum. The organised manufacturing sector had performed well in comparison to the unorganised sector. The organised manufacturing sector grew at 6.63% whereas the unorganised manufacturing sector grew at 5.34% per annum. During the period 1993-94 to 2011-12, the growth of both organised and also unorganised sectors had been accelerated as the growth rates were 7.05 and 6.65% per annum respectively.

Apart from these three core sectors, sectors like Mining and Quarrying, Electricity, gas and water supply and construction had also grown at a healthy rate. The mining sector grew at 4.80% per annum whereas the other two sectors mentioned above grew at 6.88 and 7.19% per annum respectively. Post liberalisation, mining and electricity, gas and water supply sectors had grown at a slower rate than recorded in the earlier period. The construction sector has grown tremendously in the post liberalisation period. The unorganised construction sector has been growing at 9.90% after 1993-94. (See Table 4.3, 4.4 and 4.5 for detail figures)

[14]Mahendra Dev and Pandey (2013: 90).

4.3.3 Employment growth in different sectors

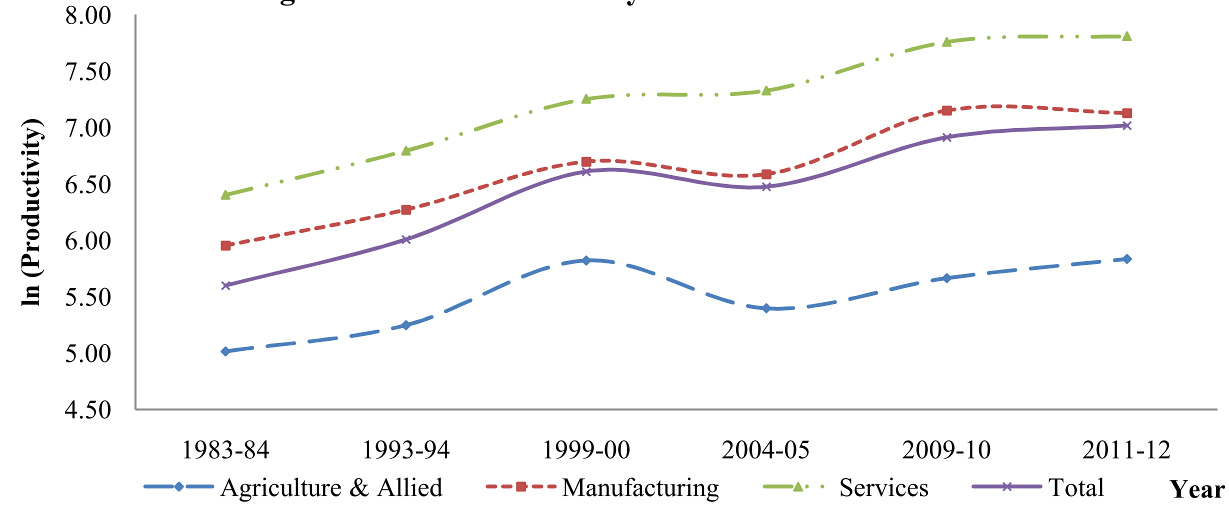
The performance of agriculture and allied activities in employment generation has been poor. It has recorded a mere growth rate of 0.01% per annum during the period of study. A cause of concern is that the employment growth in this sector has become negative during the post-liberalisation period. The negative growth of employment and large dependency of the labour force on this sector has to be addressed through job creation in manufacturing and services sector and also unskilled labour absorption of the sectors. As services in some sense need skilled labour, the burden of job creation has fallen on the manufacturing sector. But the manufacturing sector has not performed as expected. The employment growth rate of 2% per annum has been recorded for manufacturing during the period 1983-84 to 2011-12. In the post liberalisation period, the employment growth in the sector is 2.50%, but it is found that the growth rate has declined in the latter half of post-liberalisation. Employment in the service sector has grown at 2.86% per annum during 1983-84 to 2011-12. The corresponding rate in the post-liberalisation period is recorded to be 3.30% per annum. It is also found that like the manufacturing sector, the employment growth rate has fallen in the latter half of post liberalisation. The construction sector has achieved the highest growth in employment at 13.46% per annum. The post-liberalisation employment boom has been felt in the concerned sector, but this growth cannot be sustained for a longer period. This leads to a situation of chronic jobless growth which has been a burning policy issue and challenge.

Organised agriculture and allied activities employment has grown at a negative rate of 0.56% during the period of study. But growth was experienced only in the period 1983-84 to 1993-94, and for the rest of the period, it experienced a negative rate of employment growth. Organised manufacturing had fared very poorly in the study period. A negative growth rate of 2.50% per annum has been recorded. Service sector employment growth has been 0.18%, but the growth rate has fallen in the post liberalisation period. Construction sector which experiences the highest employment growth rate in overall has recorded a negative 1.39% growth in employment in case of organised sector. (See Table 4.4)

For unorganised sectors, the employment growth was 1.20% per annum during the period 1983-84 to 2011-12. The highest employment growth was registered in the construction sector at

23.76% per annum. Unorganised services sector employment grew at 3.35% per annum during the study period. Unorganised Manufacturing employment grew at 2.35% whereas unorganised agriculture employment grew at 0.01% per annum in between 1983-84 to 2011-12. In the post liberalisation period, employment in the service sector (unorganised) recorded a growth of 3.55% per annum, and unorganised manufacturing employment grew at 2.93% per annum. (See Table 4.5)

Fig 4.2: Labour Productivity in Some Selected Sectors



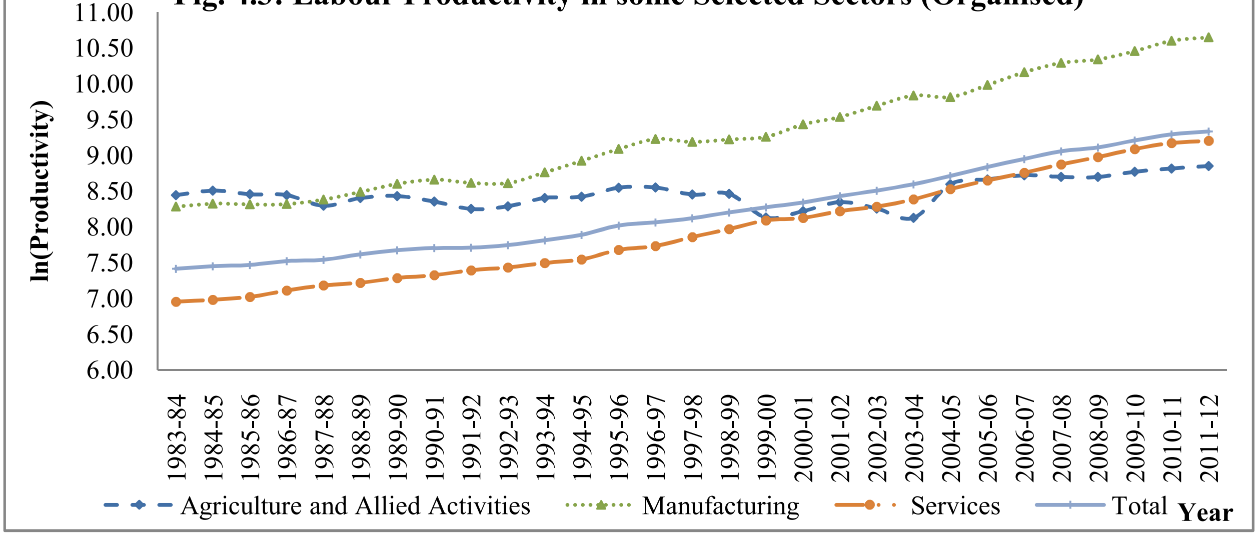
Source: Calculated from NAS, CSO and NSSO rounds on employment and unemployment situation in India.

1. For NDP: NAS, Back Series 2011, Statement 7, p. 29; and NAS, 2014, Statement 12 p. 21.
2. For Employment: NSSO 38th Round, Employment and Unemployment in India,1983-84; NSSO 50th Round, Employment and Unemployment in India,1993-94, Report No 409, Table No. 6.7.1 and 6.7.2; NSSO 61st Round, Employment and Unemployment Situation in India, Report No. 515, Table 28; NSSO 68th Round, Employment and Unemployment Situation in India, Report No 554, Table P8.

Deflator use: GDP Deflator at 2004-05 prices.

Note: Splicing method is applied to get all data at constant prices at the base year 2004-05, All figures in the series of NDP are NDP at factor cost at 2004-05 prices.

Fig. 4.3: Labour Productivity in some Selected Sectors (Organised)



Source: Calculated from NAS, CSO and Directorate general of employment and training (DGE & T)

1. For Organised NDP: NAS, 2008, Factor Incomes (1980-81 – 1999-2000), Statement 3.1 and 4.1; NAS, 2007, Statement 76.1, p. 180; NAS, 2014, Statement 76.1, p. 206.
2. For Organised Employment, the source is Directorate General of Employment and Training. The data is also available in Economic Survey.

Deflator used: GDP Deflator at 2004-05 prices.

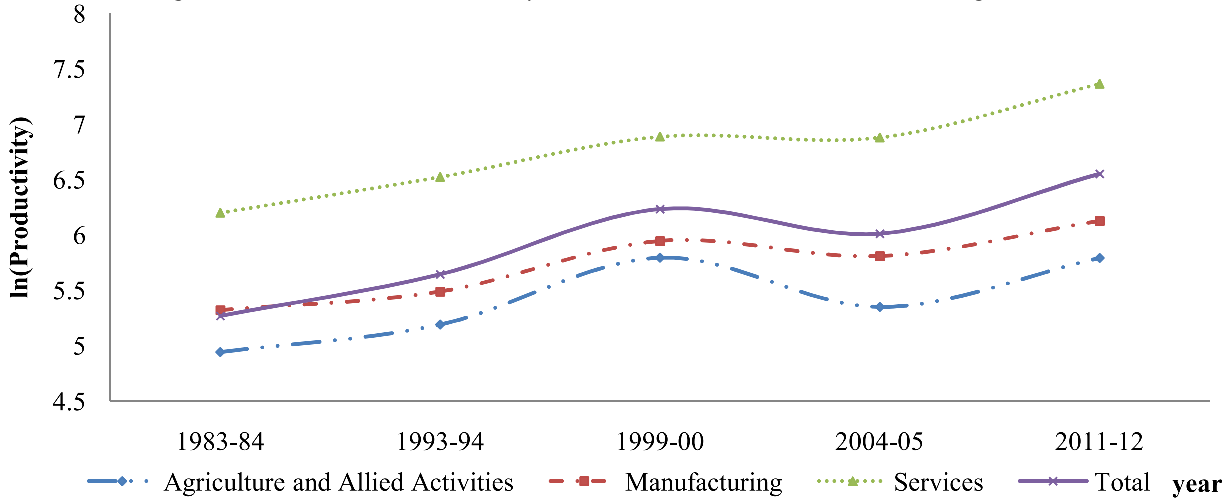
Note: Splicing method is applied to get all data at constant prices at the base year 2004-05. All figures in the series of NDP are NDP at factor cost at 2004-05 prices.

4.3.4 Labour productivity growth in different sectors

The sectoral productivity growth is highest in the case of the services sector during 1983-84 to 2011-12. In the post liberalisation period, it grew at 5.82% per annum. The growth in Manufacturing is also significant. The productivity of manufacturing was high in the post liberalisation period and particularly in the second half of liberalisation policy. The agricultural growth was very low during the study period.

The growth in the labour productivity of organised sector was higher than that of the unorganised sector. But unorganised agriculture and allied activities, mining and quarrying, and electricity, water and gas supply sector grew more than their respective organised sectors. Organised Manufacturing and services grew at 9.36% and 8.80% per annum during the period 1983-84 to 2011-12. In comparison to these figures, the respective growth in the unorganised sectors was 2.92% and 4.24% per annum.

Fig. 4.4: Labour Productivity in some Selected Sectors (Unorganised)



Source: Calculated from NAS, CSO and NSSO rounds on employment and unemployment situation in India.

1. For Unorganised NDP: NAS, 2008, Factor Incomes (1980-81 – 1999-2000), Statement 3.1 and 4.1; NAS, 2007, Statement 76.1, p. 180; NAS, 2014, Statement 76.1, p. 206.

2. For Employment: NSSO 38th Round, Employment and Unemployment in India,1983-84; NSSO 50th Round, Employment and Unemployment in India,1993-94, Report No 409, Table No. 6.7.1 and 6.7.2; NSSO 61st Round, Employment and Unemployment Situation in India, Report No. 515, Table 28; NSSO 68th Round, Employment and Unemployment Situation in India, Report No 554, Table P8.

   And DGE & T which gives employment for organised sector. So the Unorganised employment is Overall employment minus Organised employment.

Deflator use: GDP Deflator at 2004-05 prices.

4.3.5 Growth in capital stock

The capital formation is one of the essential characteristics of the development of any economy. The accumulation of capital is one of the basic needs for development process to take off. The growth in the labour productivity is positively related to the capital accumulation.[15] More of capital accumulation means more of the fixed and circulating capitals are available to the labour to work with. The labour employs the specialised machines in the process of production, and thus the division of labour becomes intensive. So capital accumulation is very much needed for greater division of labour and in turn for enhancement of labour productivity.

[15]Kaldor's technological progress function gives the relationship between the growth of labour productivity and growth in capital intensity.

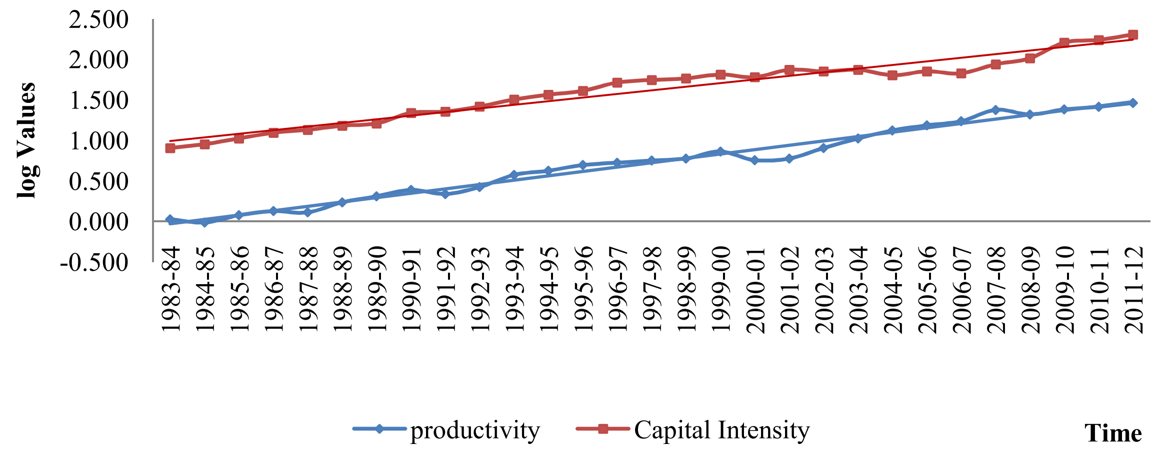
Investment in the form of fixed capital or circulating capital is required for the growth of productivity in each sector. Capital formation in Agricultural sector increases the productivity in the sector. It is also suggested that one way to solve the persistent agricultural crisis is the increased use of roundabout technology. The increase in the investment in the manufacturing sector leads to a strong base of the real economy, and it helps in the labour migration from primary sectors.

During the period of study from 1983-84 to 2011-12, the net capital stock for the economy grew at a rate of 6.28% per annum. In the post-reforms period, the growth in NCS increased to 7.32% per annum. The reforms showed its results in the second half of the reforms. The growth rate in the first half was 5.93 and that of in the second half was 9.70% per annum. A sector-wise look into the growth in capital stock showed a significant difference in the rate of growth in capital formation in each sector. The manufacturing sector had achieved a high rate of growth in capital stock during the period of study at 7.99% per annum. In the post-reforms period, it grew at 8.45% and in the second half of the post reforms period; it achieved 10.69% growth per annum specifically. Services sector recorded a rather slower rate of growth in capital formation. The growth rate was 6.14% per annum. In the post reforms period it achieved some momentum and grew at 7.32%, but there was a significant shift in the growth rate of capital stock in the service sector in the second half of the post-reforms period. During the period 1993-94 to 2004-05, it capital stock growth in the service sector was 6.24%, and it grew to 9.49% in the second half. Increased deregulation, disinvestment and privatisation of sectors like telecom and communication, transport and airways helped the cause of growth capital stock in service sector. The Agricultural and allied activities gained capital stock at a much slower rate. It grew at 3.64% per annum during 1983-84 to 2011-12. In the post-reforms period, the growth was 4.45% per annum. (See Table A4.2 for detailed results)

4.4 Trends in output and productivity for registered manufacturing

Discrediting the TFP as a non-existent entity gives very strong reason to analyse the Labour productivity growth. Studies on productivity in Indian manufacturing suggest an increasing TFPG during the post-liberalisation period. As in the classical economics, labour productivity growth triggers output growth and the advancement of technology is an embodied one; it is very much essential to analyse labour productivity and capital intensity (capital_labour ratio) growth simultaneously.

Fig. 4.5: Growth of Labour Productivity & Capital Intensity in Registered Manufacturing



Source: Calculated from ASI Database.

Deflator: GDP Deflator at 2004-05prices.

Note: Logarithm values of labour productivity and capital intensity are taken to do up the scale problem in diagram.

Fig.4.5 depicts the trend of labour productivity and the capital intensity (capital labour ratio) in the manufacturing sector. The dominant feature of the figure is that the long-term trend of labour productivity and capital intensity are increasing in the post-reform period. They almost go parallel during the period, but the growth rate is higher in case of labour productivity. A sharp increase in the capital intensity is accompanied by a moderately rising labour productivity up to the mid-80's (Ahluwalia, 1991). So it is confirmed that the increase in capital intensity is pulling the labour productivity to incline.

The trend of capital-labour ratio for the organised manufacturing has shown an overwhelming increase in the capital intensity over the study period. The capital per unit of labour has increased about three times over the period. The capital intensity recorded a growth from 2.47 lakh in 1983-84 to 10.99 lakh in 2011-12 whereas labour productivity increased from 1.025 lakh in 1983-84 to 4.304 lakh in 2011-12. The growth rate of capital-labour ratio was 4.93% per annum for the whole manufacturing industry during the study period (see Table 4.6).

The rising trend has been very smooth throughout the post liberalisation period. The labour productivity increased by 5.57 % per annum during the study period whereas the capital intensity increased at 4.93 %. In the 80s the growth rate of capital intensity was 6.68 % in comparison to 5.9 % labour productivity. In the post-reform period, capital intensity growth was very slow compared to that of labour productivity. During the study period, the employment growth was very slow but the real NVA and real fixed capital growth at a significant rate of 6.92 % and 6.27 % respectively (see Table 4.6).

Table 4.6: Growth Rate of Strategic Variables for Registered Manufacturing (in percent)

Variables	1980-81 to 2012-13	1980-81 to 1989-90	1990-91 to 2012-13	1990-91 to 1999-00	2000-01 to 2012-13
Net Value Added	6.92	5.92	7.15	6.65	12.13
Labour Productivity	5.57	5.90	5.41	5.92	6.45
Total Person Engaged	1.28	0.02	1.65	0.69	5.34
Residual	0.07	0.00	0.09	0.04	0.34
Capital-Labour Ratio	4.93	6.68	4.09	5.88	5.03
Fixed Capital	6.27	6.71	5.81	6.61	10.63

Note: The figures are Trend growth rates showing the antilogarithms of the relevant regression coefficient minus one when the equations are of the form log Y = a + b T and T refers to time.
Source: Calculated from ASI.
Deflator used: GDP Deflator. All Values are at 2004-05 prices.

4.4.1 Use-based classification

A detailed level of disaggregation in the form of use based sector gives an economically meaning full analysis to the productivity and growth. The manufacturing sector has been dividing into four sectors i.e. basic goods, capital goods, intermediate goods and consumer goods. The use-based classification is based on the IIP classification. From the policy perspective, it is very much important to analyse productivity and growth according to their use. For a high growth of consumer goods, it is very much important to have a developed intermediate and capital goods sector. Various plans (for example Nehru-Mahalanobis model) have been formulated to increase the base for the basic goods industries. During the 5th plan, emphasis has been put on the growth of consumer goods sector.

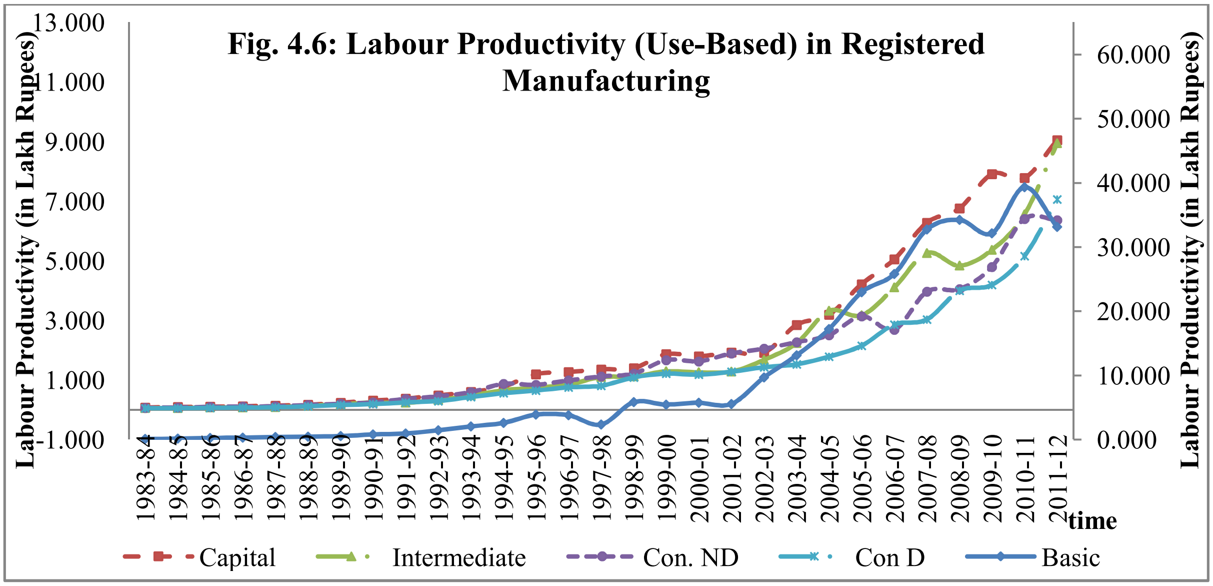


Fig. 4.6: Labour Productivity (Use-Based) in Registered Manufacturing

Source: Author's calculation. Data collected from ASI database.

Deflator: GDP Deflator at 2004-05 prices.

Note: The secondary vertical axis is meant only for the basic goods sector. All other sectors are labelled in the primary vertical axis.

From the Fig. 4.6, we get a view of labour productivity trend in different manufacturing sector in different use based activity. The largest use based sector in India organised manufacturing is the consumer goods sector which consists around 33 % in 2012-13. Among the consumer goods, the consumer non-durable is predominant. The intermediate sector has a share of around 27 % in 2012-13. A look at the trend of these use based sector will confirm a declining tendency of intermediate sector during the study period. It is the most important sector because it supplies inputs into the other manufacturing sector. The consumer goods sector included critical industries like Food Products, Textile Product, Paper Product, Jewellery and Leather Product. Most of these industries are labour intensive industries. The capital goods sector is crucial for technology induction which has long term effect on the productivity growth. The important manufacturing sectors in this group are machinery, electrical machinery, transport equipment, non-metallic products and petroleum products. So it is important to look at the productivity trend of these use based sector. From the above fig. we can find that the labour productivity of all the use based sector has grown in the study period, but the growth in the basic good sector is very alarming. The labour productivity of basic good sector was very low during the pre-reform period, but it gained pace in the second half. During the first phase i.e. pre-reform, the divergence between labour productivity among the sectors are almost negligible but the gap increased in the basic good sector. The trend of labour productivity of capital goods sector shows a widening gap than the intermediate and consumer goods.

4.4.2 Factors explaining labour productivity growth

Increasing returns to scale

The growth of per capita output depends upon the growth of productivity and the growth of share of working population in the total population. The demand for the labour is very much associated with the technique of production and the type of capital used. If the technology of production is labour-augmenting, then the share will be high, and there will be a rise in the output growth. So the output growth is caused directly by the growth of labour productivity. In the pursuit of explaining the causes of growth of labour productivity, Adam Smith has given a chain of cumulative causation in his literature.[16] He has attributed division of labour as the prime cause of labour productivity growth which operates with splitting down the complex activities. Kaldor identified several facts like oligopolistic structure of manufacturing, spatial concentration of the industrial activity, sustained difference between the rate of output and productivity growth. These facts are well explained by increasing returns. Kaldor has argued that the manufacturing sector is subjected to the increasing returns. The increasing returns arise within the plant and enterprise. Average plant cost per unit of output decreases with the size of operation. The large multi-product firms arose from their capacity to capture the growing market. The oligopolistic nature of the manufacturing does not allow the market to become competitive when its size increases.

An increase in the level of aggregate output permits the greater division of labour and also the use of capital-intensive technology. The circular and cumulative relation between increasing returns and growth of output has been the basis of persistent income disparity. The learning by doing (Adam Smith has notified it as inventions and innovation induced by

[16]Adam Smith in his magnum opus '*Wealth of Nations*' has given a detailed explanation of productivity caused by increasing division of labour. The simple example of Pin Factory is a great demonstration of how the division of labour helps in raising the production.

experience) encompasses both incremental improvement in efficiency and generation of new technology. The technological changes are taken as by-product and are endogenously introduced through new capital in contrast to the neo-classical proposition where these are treated as exogenous.

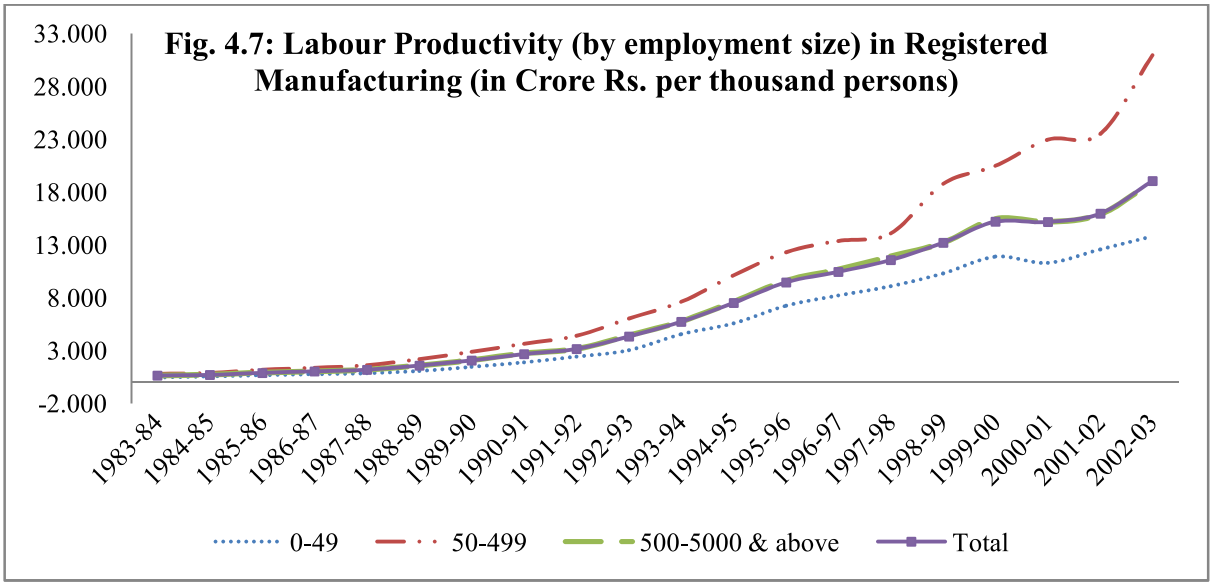


Fig. 4.7: Labour Productivity (by employment size) in Registered Manufacturing (in Crore Rs. per thousand persons)

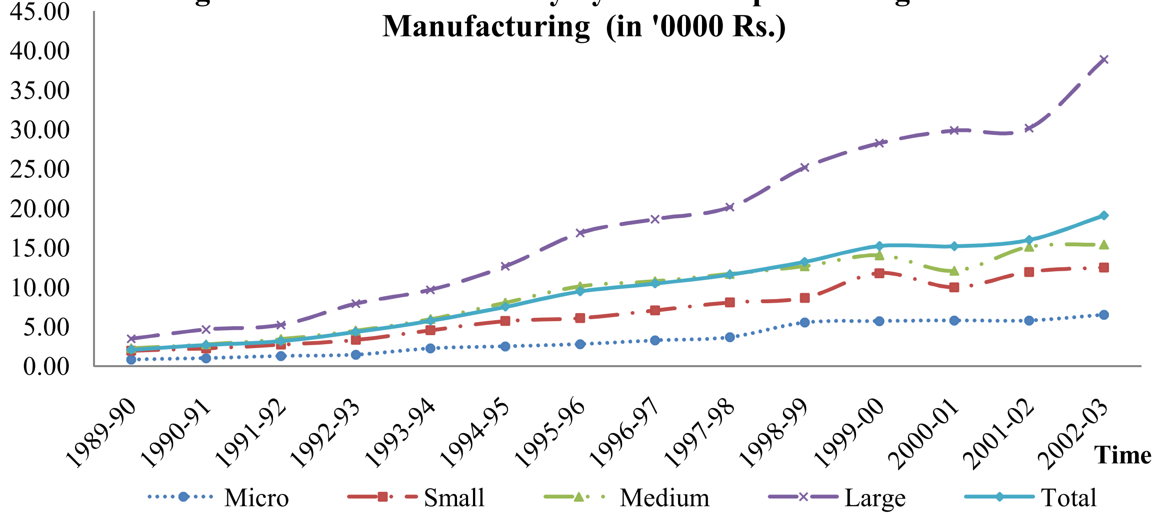
Source: Author's calculation. Data collected from ASI Database.

Deflator: GDP deflator at 2004-05 prices.

Note: Data is available up to the year 2002-03 according to employment size.

The manufacturing labour productivity by size of labour employment shows that the medium (50-499) employment size factories have a high labour productivity in comparison to the low employment size factories and large employment size factories (refer to Fig. 4.7). The labour productivity of the low employment factory was 0.24 crore per thousand persons in the year 1980-81 which increased to 13.8 crores per thousand rupees in the year 2002-03. In the medium employment size, the productivity increased from 0.38 crore to 30.95crore per thousand person rupees during the referred period. In high employment factories, the labour productivity increased from 0.309crore per thousand person rupees in year 1980-81to 18.99crore per thousand person rupees in the year 2002-03. The productivity level of the medium (50-499) employment size factories was higher than the total manufacturing and the growth of the productivity of these plants were high. The small factories predominantly labour-intensive sectors and these sectors do not have access to improved technology. The medium scale sectors which are predominant in case of Indian manufacturing are growing at significant rate. The access to the new capital and enlarged market due to opening up the economy, help these factories to grow rapidly.

Fig. 4.8: Labour Productivity by Size of Capital in Registered Manufacturing (in '0000 Rs.)



Source: Author's calculation. Data collected from ASI database.

Deflator: GDP deflator at 2004-05 prices.

Note: Data is available up to the year 2002-03 according to capital size.

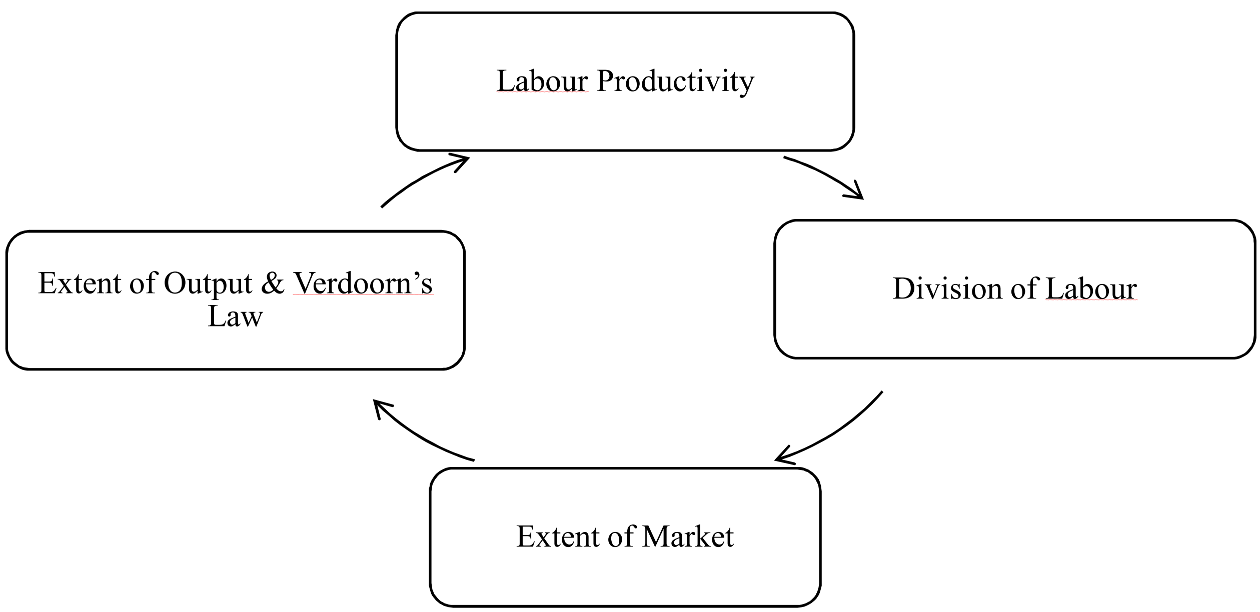
The labour productivity of the manufacturing industry according to the size of capital provides evidence of increasing returns to scale (see Fig. 4.8). According to capital size, the factories are defined in four scales: The micro industries, small scale industries, medium scale industries and the large scale industries. The division is made according to the definition given by MSMED Act, 2006. The productivity of the elite capital employed factories is continuously higher than the low-capital size factories over the years. The large capital size factories had a labour productivity of 0.346 lakh rupees in the year 1989-90, and it has increased up to 3.89 lakh rupees in the year 2002-03. The large capital-size factories enjoyed a favourable regime. High capital investments were encouraged, and the foreign capitals were also allowed in the manufacturing sector. The higher capital firms have had larger productivity due to the operation of increasing returns to scale. During this period the low and medium capital size firms also achieved higher labour productivity, but they didn't enjoy the upper hand. In these factories, the productivity did not grow as rapidly as the large capital size factories.

Verdoorn's law and Kaldor's technical progress function

Verdoorn's law describes the relationship between productivity and output growth. As the growth of output rises, the growth of labour productivity increases. The labour productivity grows with output due to learning by doing. The law is an outcome of the operation of increasing returns to scale. Higher productivity and the availability of more productive capital goods are dependent upon the cumulative output. High growth rate of output and productivity can take place only if new products are introduced, and the demand for them increases significantly.

The positive feedback from output to demand results in higher productivity and gets reflected on competitiveness, endogenous specialisation. But the productivity growth can be observed if the new product can be sold successfully in the extended market. The expansion in the demand of the market is backed by the growth of output. The Verdoorn's law is defined as, 'Productivity levels are higher in those sectors which are experiencing faster growth of output.'

Circular Causation Model 1[17]*:*



The classical causation can be summarised as growth occurs when the per capita income rises. The total income is the multiplication of productivity and the total labour employed. Division of labour gives rise to productivity, and it comes from the extent of market. To this

[17] This is a design of circular and cumulative causation model of growth. See, Toner (1965: Chap 6, 134).

series of causation if we add the Verdoorn's law then there will be circular causation. This causation continues with the cycles, and the economy will grow in a circular spiral diverging net.

The Verdoorn's law described a positive relationship between the growth of labour productivity and growth of output. The law can be stated as,

$$\delta(LP) = \alpha_1 + \beta_1\delta(V) \qquad (3)$$

Here, the growth (δ) rates are Annual growth rate.

$$\delta(LP) = 0.02 + 0.55\delta(V)$$

P (β_1) = 0, Adjusted-R^2 = 0.54, D-W Statistics = 2.38, F-Stat = 37.63

From the regression run to fit the model stating the Verdoorn's law, we get that the relation described by the Verdoorn's law is true in Indian manufacturing industry. The $\beta_1$coefficient which signifies the relation between the growth of productivity and growth of output (output here is NVAR) is 0.55 and is significant even at 1% level for the overall manufacturing. The adjusted R^2 satisfies the condition of a good-fit. The D-W statistics confirms the absence of autocorrelation in the model specified above (for details see 'Equation 3').

The neoclassical idea between a movement along a production function (due to relative price changes) and shifts in the production function (due to exogenous technological change) is rejected. Technical progress is embodied in new capital goods, and the rate of growth output per worker is determined by the rate of growth of capital-labour ratio. 'The recognition of the existence of a functional relationship between the proportionate growth in capital and the annual proportionate growth in productivity shows the futility of regarding the movements in the capital/output ratio as dependent upon the technical character of the stream of inventions-according as they are predominantly "labour saving" or "capital saving" in character'(Kaldor 1957).

He has defined a position of long-run equilibrium at the point where the growth of capital and the growth of output are equal. Anything right to the of the point will be regarded as the accumulation of capital-saving technical, and that of to the left will be regarded as the labour saving technical progress. This relationship can be examined by running a regression from growth of capital-labour ratio to growth of labour productivity.

$$\delta(LP) = \alpha_2 + \beta_2 \delta(K/L) \quad (4)$$

$$\delta(LP) = 0.04 + 0.21\delta(K/L)$$

P (β_2) = 0.32, Adjusted-R^2 = 0.001, D-W Statistics = 2.08, F-Stat = 1.02

From the regression run from the growth of capital-labour ratio to the growth of labour productivity, it is found that the Kaldor's Technological progress function does not hold good for the Indian manufacturing Industries. The β_2 coefficient which defines the relationship is 0.21 and is insignificance. The adjusted R^2 of the model is 0.001 which means the model is not a good fit. The F-stat is also very low 1.02 which means the model is insignificant itself (for details see 'Equation 4').

From the above practice of running regression, it is clear that the Verdoorn's law is found to be true and the Kaldor's primitive technological progress function is false. So to make a better explanation of productivity growth we have resorted to a regression which gives a combined representation of both Verdoorn's law and the Kaldor's primitive technological progress function. The model of the regression is

$$\delta(LP) = \alpha + \beta_1 \delta(V) + \beta_2 \delta(K/L) \quad (5)$$

$$\delta(LP) = 0.004 + 0.55\delta(V) + 0.21\delta(K/L)$$

P (β_1) = 0, P (β_2) = 0.15, Adjusted-R^2 = 0.55, D-W Statistics = 1.95, F-Stat = 20.63

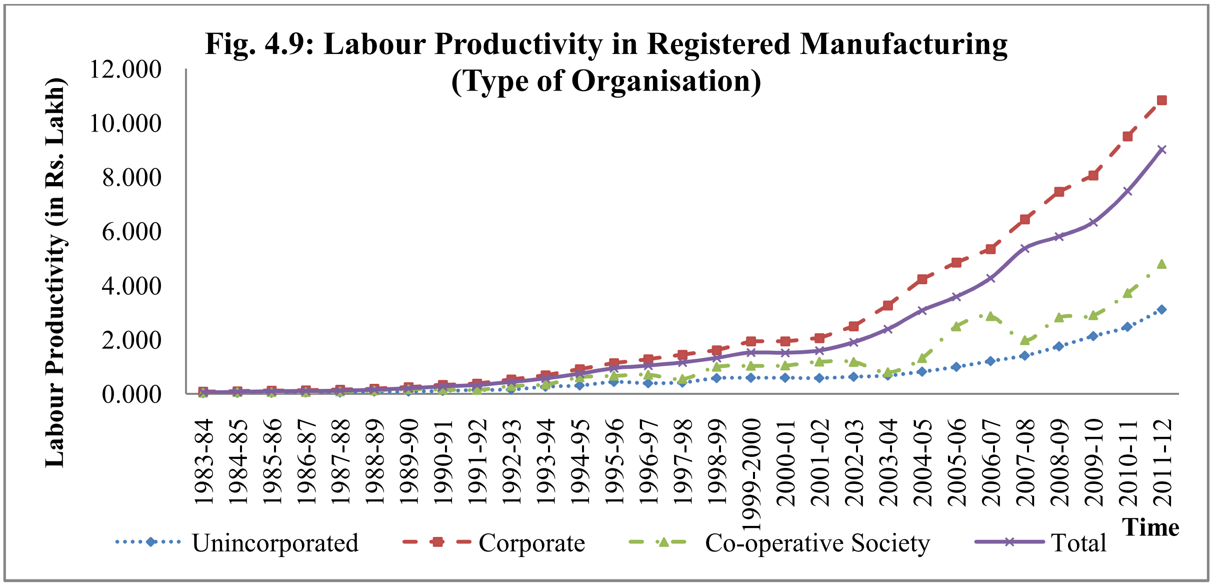
The manufacturing industry is subjected to the increasing returns, and the Verdoorn's law is based on the same proposition. Again Kaldor through his cumulative causation theory brings the positive causal relationship between growth of capital-labour ratio and growth of productivity. Here the combined effect of both the laws is examined for the manufacturing industry as a whole. The regression result confirms that the Verdoorn's law, as well as the Kaldor's proposition, holds for the manufacturing in India. The coefficient of growth of NVA (β_1) is 0.55 and is significant for the manufacturing industry at 1% level. Like also the coefficient of growth of capital-labour ratio (β_2) is 0.21 and is significant at 15% level. The F-statistics shows that the model gives a significant result and is a good-fit (for details see 'Equation 5').

The positive effect of output growth in the increasing productivity dependent upon the operation of increasing returns to scale. The circular causation in the Verdoorn's law is very much dependent upon the extent of market. The size of demand leads to an extension of output. The scale economies of large production and the use of intensive roundabout methods allow the manufacturer to allow for more productivity growth. So the concepts of increasing returns to scale and Verdoorn's law make way for greater division of labour and greater productivity growth.

Productivity by types of organisation

Labour productivity of the manufacturing sector differs according to the type of organisation. The productivity of the corporate sector is very high while the unincorporated manufacturing sector has a low labour productivity. The thrust of the eighth plan in case of the manufacturing sector may be to initiate the removal of policy control, private de-reserving and de-licensing. So basically the aim was to provide an important role to the corporate sector. The division of the manufacturing sector by types of the organisation could be incorporated as one of the explanations for the operation of scale economies. The corporate sector manufacturing could resort to the large-scale operation in terms of factor employment. The size and scale of operation in the manufacturing by co-operative societies and unincorporated organisation is small in comparison to the corporate sector.

During the period of study, the labour productivity of the corporate sector was very high (see Fig.4.9). It was 0.039 crore rupees per thousand person in the year 1980-81 which increased to 12.41crore rupees per thousand in the year 2012-13. The productivity of the unincorporated enterprises, as well as the co-operative society, did not increase much as compared to the productivity of corporate enterprises.



Source: Author's calculation. Data collected from ASI database.

Deflator Used: GDP Deflator at 2004-05.

4.5 Sources of growth in India

The conventional approaches try to locate the sources of growth in output through input growth. The output growth in the Growth Accounting Approach is the weighted sum of the input growth and a residual which is termed as Total Factor Productivity growth (Refer to Chapter 2). The neoclassical approach by giving importance to input growth and TFP growth, neglects the process of growth. It does not throw light on how the inputs grow or the interaction of the inputs with each other. Separability of input growth is the synthesis in neoclassical explanation of growth. But Classical economics see output growth as the sum of labour productivity growth and employment growth. The simple explanation of growth in the classical doctrine helps in understanding the process more. The growth of output is the outcome of a circular and cumulative causation of labour productivity and employment. Growth in labour productivity and growth in employment can be written in separate figures but they inherit process of growth explained by capital accumulation, economies of scale and division of labour.

From Table 4.2, it is found that there is an increasing trend in the output over the period 1983-84 to 2011-12. The labour productivity also rises during the period but the divergence between organized and unorganized labour productivity is increasing. The employment trend shows a very little increase and is dominated by the unorganized sector. In Table 4.3, Table 4.4 and Table 4.5, the decomposition of Output growth is given by Labour productivity growth and Employment growth for different sub-periods and for broad sectors as well as on the division of organized and unorganized sectors. The economy's NDP_{FC} grew at 6.41% for the study period 1983-84 to 2011-12, and at 7.29% for the study period 1993-94 to 2011-12. The employment growths estimated are 1.16% for the period 1983-84 to 2011-12 and 1.43% for the period 1993-94 to 2011-12. The labour productivity growths in these two periods are 5.19% and 5.78% respectively. It is found that much of the output growth is explained by productivity growth in both the period. In different economic sectors also productivity growth is the factor that explains more of the output growth except for the construction sector. In the construction sector the employment growth during the period 1983-84 to 2011-12, is 13.46% per annum where as the growth in productivity is -5.53% per annum. In the post-reforms period employment growth was 13.25% whereas productivity growth was -4.26% per annum.

In case of organized sector, for the period 1983-84 to 2011-12, NDP_{FC} grew at 7.34% per annum but employment growth during this period was a negative of 0.13% per annum. In case of organized sectors it is the labour productivity growth that explains more of the output growth. Construction also registered a negative employment growth while a high productivity growth. From the Table 4.4, it is clear that in the post-reforms period the employment growth become negative and the labour productivity growth was very high. The problem of jobless growth aggravated during this period.

In the unorganized sectors, output growth was slower than that of the organized sector for the study period 1983-84 to 2011-12. It could be seen in Table 4.5, that the employment growth was highest in case of construction sector. In comparison to the employment growth of the whole economy, manufacturing employment and services employment grew faster. Growths in each of the broad sectors are explained by the productivity growth and very slow or negative employment growth. In case of unorganized construction the productivity growth was negative.

Table 4.6 explains the value added in registered manufacturing sector grew at 6.92% per annum during the period 1980-81 to 2012-13. In the recent period from 2000-01 to 2012-13, there is a surge in the value added growth. In the recent period, value added growth in registered manufacturing is much more symmetrically explained by productivity growth and employment growth. In the post-reforms period, high employment growth was registered in Textile product, Leather product, Rubber, plastic and petroleum product, Non-metallic mineral product, and Manufacturing nec., and Recycling. In these sectors the productivity grew at comparatively lower rate. These manufacturing sectors are mainly labour intensive.

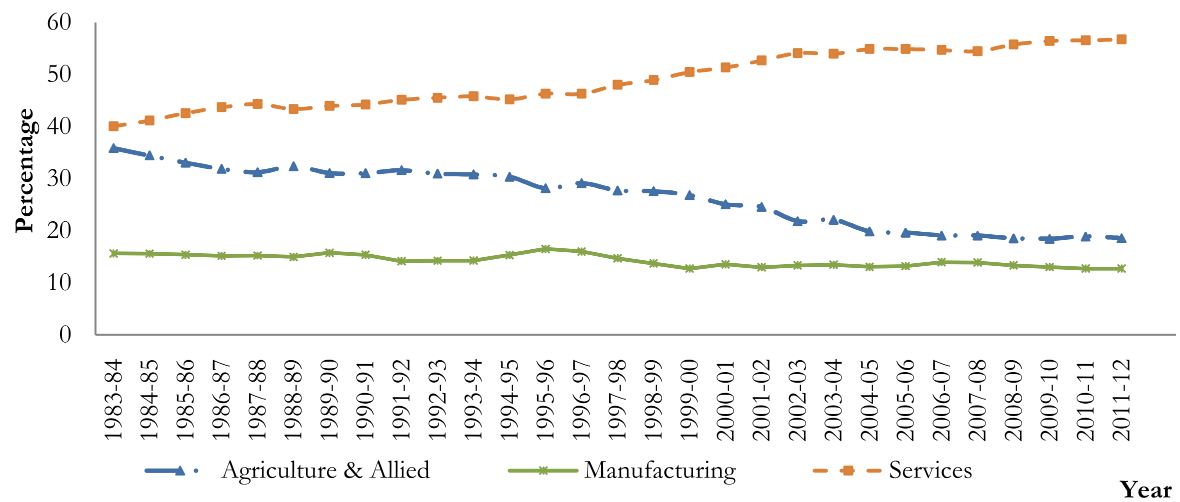
4.6 Structural changes in Indian economy

4.6.1 Composition of NDP_{FC}

There have been considerable changes in the composition of Indian economy. A significant drop in the share of the Agricultural and allied sector is associated with a steady incline in the share of services. At the start of the study period in 1983-84, the share of agriculture was 35.88%, but it declined to 18.6% in 2011-12. At the same period, the share of services had increased from 40.01% to 56.74%. The share of manufacturing sector remained almost stable during the period. In the year 2011-12, the share was 12.75% of the NDP. In the period 1983-84 to 2011-12 the share of construction has increased from 4.69% to 8.68%. The other sectors like Mining and quarrying and Electricity, gas and water supply had a very low share in the NDP, and the shares remained very steady. (Refer to Fig. 4.10)

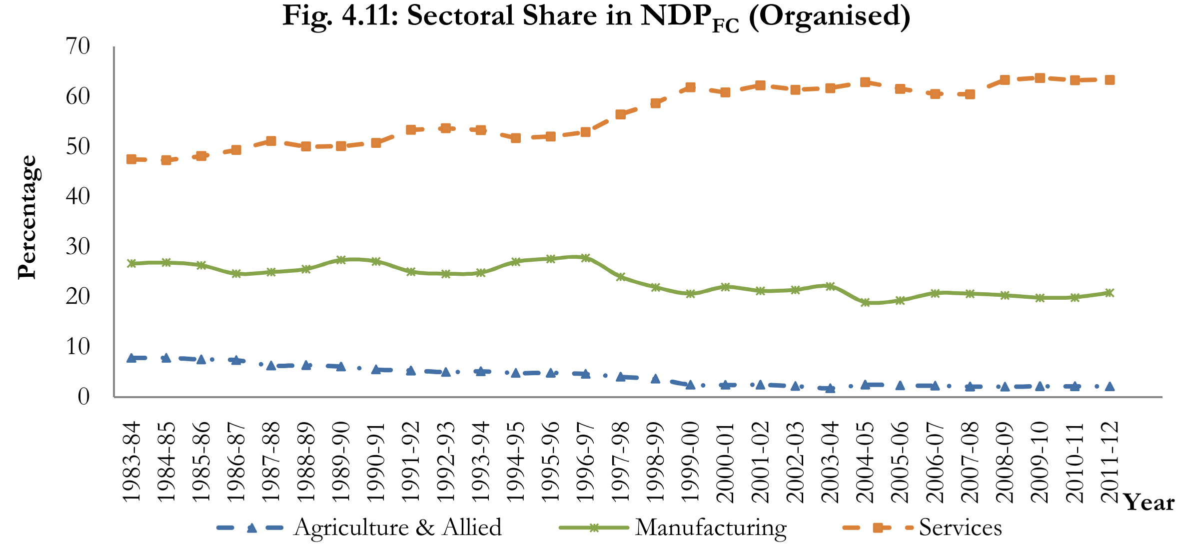
In Fig. 4.11, the composition of organised sectors is presented. In the organised NDP also services had dominated. The share of agriculture was quite low in organised sector NDP. Its share was 7.79% in 1983-84 which even declined to 2.08% in 2011-12. Organised services were the largest beneficiary in the post-liberalisation period. Its share increased from 47.45% in 1983-84 to 63.29% in 2011-12. The organised manufacturing sector, on the other hand, experienced a decline in its share. The share of the sector declined from 26.65% in 1983-84 to 20.79% in 2011-12. From the Figure 4.10, one can clearly see a mirror image of the increase in the share of services and the fall of the share of manufacturing. Other sectors like Mining, Electricity, Gas and Water supply and construction had maintained their shares throughout the period. So services gained the dominance in expense of the manufacturing and agricultural sector.

Fig. 4.10: Sectoral share in NDP_{FC}



Source: Calculated from National Accounts Statistics, Back Series 2011, Statement 6, p. 23; and NAS, 2014, Statement 12, p. 20.

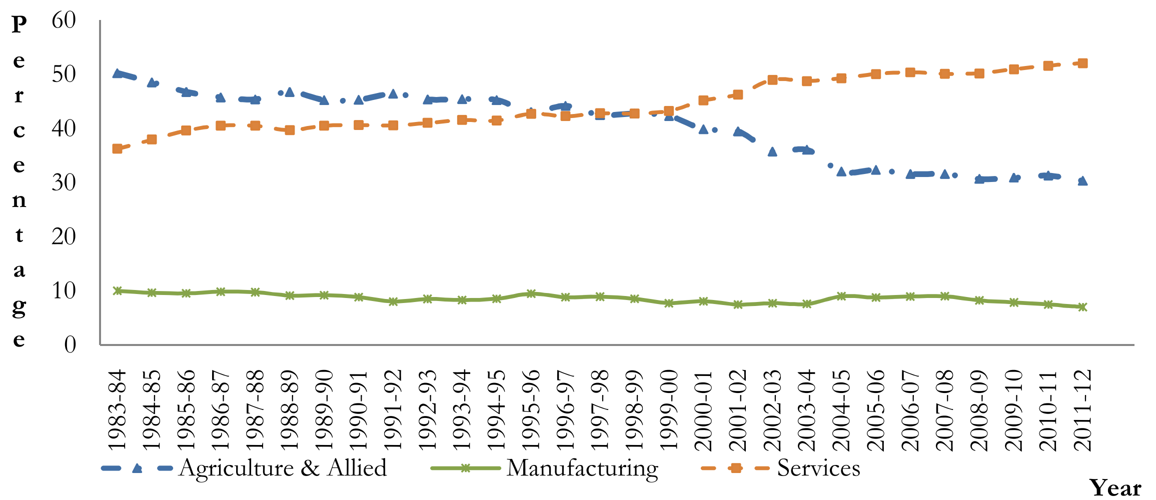
Fig. 4.11: Sectoral Share in NDP_{FC} (Organised)



Source: Calculated from NAS, 2008, Factor Incomes (1980-81 – 1999-2000), Statement 3.1 and 4.1; NAS, 2007, Statement 76.1, p. 180; NAS, 2014, Statement 76.1, p. 206.

In the Fig. 4.12, the sectoral composition is given for the unorganised sectors. At the start of the period agriculture and allied activities had greater share than the other sectors. But this sector lost its share. In 1983-84 the share of agriculture and allied sector was 50.25% which declined to 30.36% in 2011-12. The services sector had taken over the agriculture sector. The share of this sector in the unorganised NDP was 37.26% in 1983-84 which increased to 52.06%in 2011-12. The contribution of unorganised manufacturing declined although the share of unorganised construction improved during the period of study.

Fig. 4.12: Sectoral share in NDP_{FC} (Unorganised)



Source: Calculated from NAS, 2008, Factor Incomes (1980-81 – 1999-2000), Statement 3.1 and 4.1; NAS, 2007, Statement 76.1, p. 180; NAS, 2014, Statement 76.1, p. 206.

From the sectoral growth and composition, it can be concluded as the services sector has emerged as a clear victor after the reforms have taken place. The Kuznets-Chenery hypothesis for capitalist development for the western countries seems to fail in case of India. But studies of Veeramani (2004) have pointed out that India is not an outlier as the service sector growth is at par with the international experience.[18] The rate of growth of the service sector was more than the anticipated rate by Kuznets and Chenery. The performance of Indian manufacturing sector was very poor during the 80's. Removing the shackles on manufacturing has not been very successful which is the main cause behind stagnant growth of this sector. However, the job-creating capacity of manufacturing and services sector has not been explored (Papola and Sahu, 2012).[19]

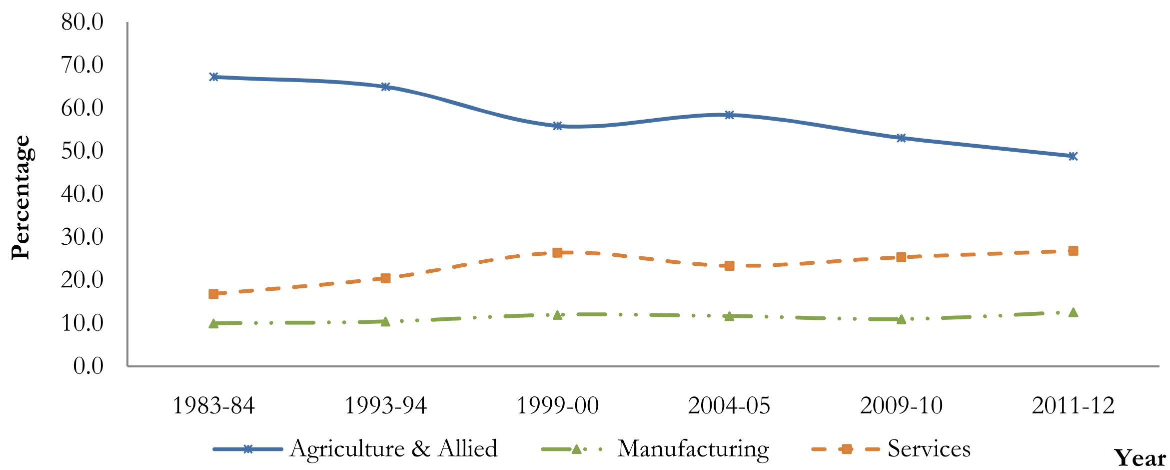
[18]See, Veeramani (2004).

[19]See, Papola and Sahu (2012).

4.6.2 Composition of employment

The sectoral composition of employment shows a quite different view. It is natural that with the sectoral transformation of the economy towards service sector dominance, the labour force should also migrate towards those sectors. But in case of India, much of the employment comes from Agriculture and allied sector. In the year 1983-84, the share in the total employment of the sector was 67.3% which steadily declined to 48.9% in the year 2011-12. The share of the service sector, the second largest employer grew from 16.9% in 1983-84 to 26.9% in 2011-12. Manufacturing sector which is supposed to be the job provider for the unskilled worker lagged behind and its share in total employment was just 12.6%. The share of employment in the construction sector grew tremendously from 0.4% in 1983-84 to 10.6% in 2011-12 while the contribution of Electricity, gas and water supply and Mining to the total employment decline during the period of study. (See Fig. 4.13)

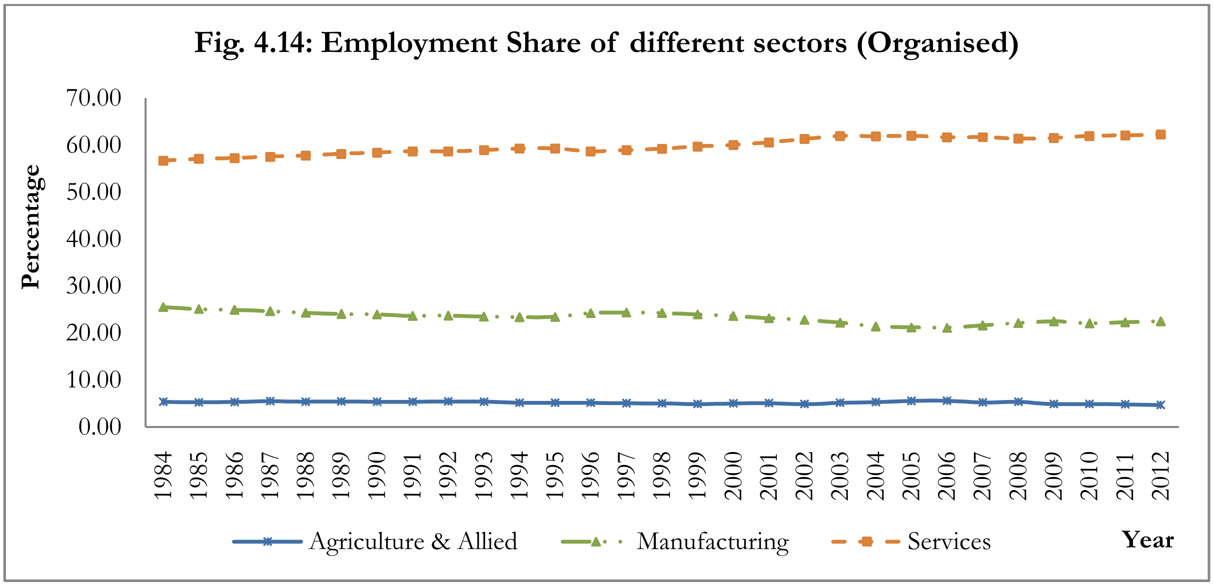
Fig. 4.13: Employment Share



Source: Calculated from : NSSO 38th Round, Employment and Unemployment in India,1983-84; NSSO 50th Round, Employment and Unemployment in India,1993-94, Report No 409, Table No. 6.7.1 and 6.7.2; NSSO 61st Round, Employment and Unemployment Situation in India, Report No. 515, Table 28; NSSO 68th Round, Employment and Unemployment Situation in India, Report No 554, Table P8.

The share of organised employment in the total employment has been very low. It is around 7% of the total employment in 2011-12. The much larger informal sector employment can be seen as a poor quality of employment generation. Of the organised employment, services constitute the highest percentage. Its share was 56.67% in 1984 which increased to 62.28% in

2012. Organised manufacturing sector captures only 22.54% of the total organised employment. The share of agriculture and allied activities in the organised employment is very low as it constitutes only 5% of organised employment. (See Fig 4.14)

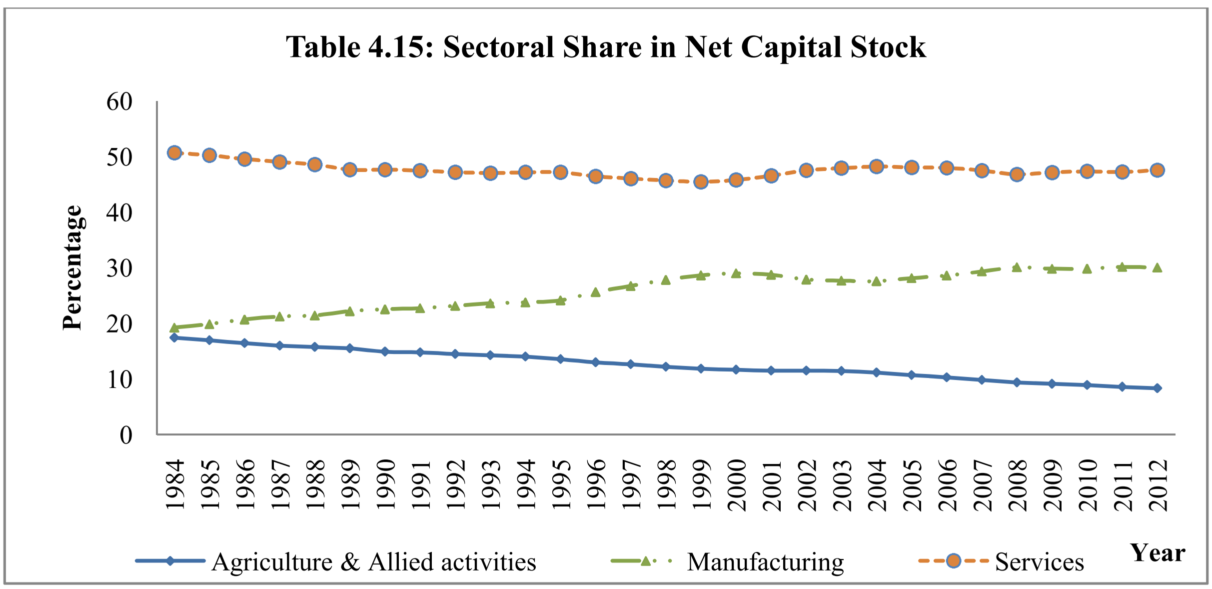


Source: Calculated from Organised employment data from DGEandT.

Much of the generation of employment depends on the unorganised sector. Many people left agriculture and shifted to more productive sectors. There is a positive relation between share in GDP and employment share in case of manufacturing (D' Souza and Bhattacherjee, 2011). So the potential of manufacturing sector to generate employment has to be realised. To increase productivity of manufacturing sector, the enterprises resorted to cost-cutting policies. So instead of bringing the temporary and casual worker in manufacturing sector, it brings out a small group of permanent and skilled workers. Due to rigid labour laws and the less flexible labour markets, the manufacturing sector has not succeeded in attaining what has been expected from it. The situation of significant proportion of causal worker in the informal service sector and high ratio of regular workers in formal manufacturing sector in comparison to the service sector point out at service sector being more into the casualization of labour. This degrades the quality of employment generated in the service sector.

4.6.3 Composition of net capital stock

Figure 4.15 depicts the share in Net Capital Stock of the different sectors of the economy. From the figure, there is a clear picture of declining share of Agricultural and allied activities. The share declined from 17.46% in 1983-84 to 8.37% in the year 2011-12. The share of Services sector was highest in the net capital stock. In the year 1983-84, the service sector contributed around 50.67% which fell slightly to 47.55% in the year 2011-12. The share of manufacturing sector increased from 19.28% in the year 1983-84 to 30.06% in the year 2011-12. The increase in the share is due to the high growth rate achieved in the post-reforms period. It is worth noting that the shares of other sectors were very low despite high growth in capital formation in the post-reforms period.

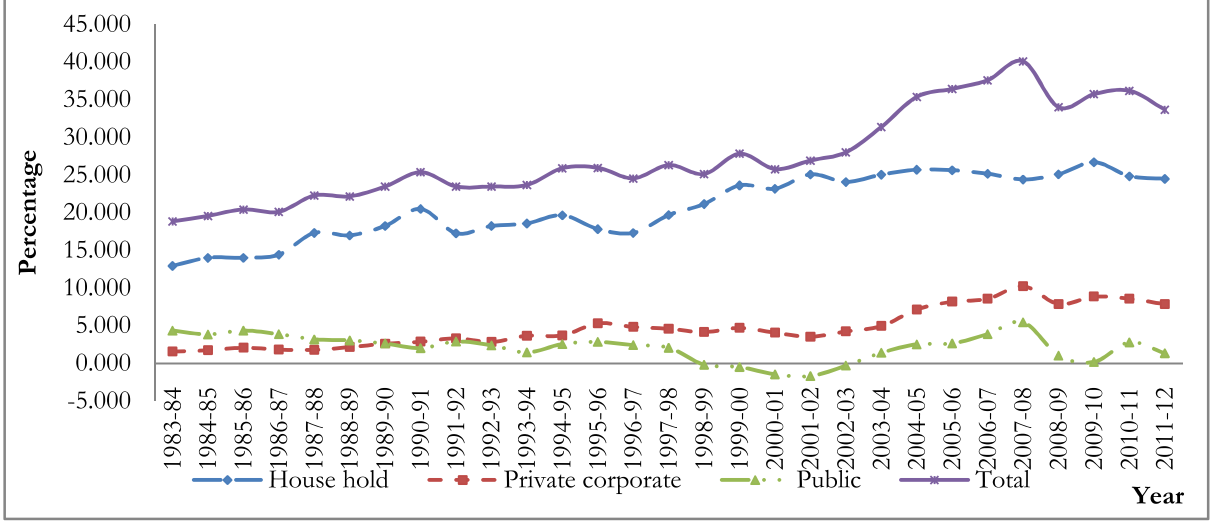


Source: Calculated from National Accounts Statistics.

1. NAS, Back Series, Statement 17, p. 154
2. NAS, 2014, Statement 22, p. 55

The gross domestic savings rate in India has been very steady and remained in the range 20-25% over a major stretch of period. In the recent years, there is a surge in the saving rate. In 1983-84, the rate was 18.82% which increased to 40% in the year 2007-08 and followed by a fall in the rate in subsequent years. The contribution of household and private corporate sector to the gross domestic savings has been significant while that of public sector saving is very low. During the period 1998-99 to 2002-03 the savings rate of public sector had gone negative. The public sector savings were very volatile. Particularly, the household gross domestic savings rate has increased steadily.

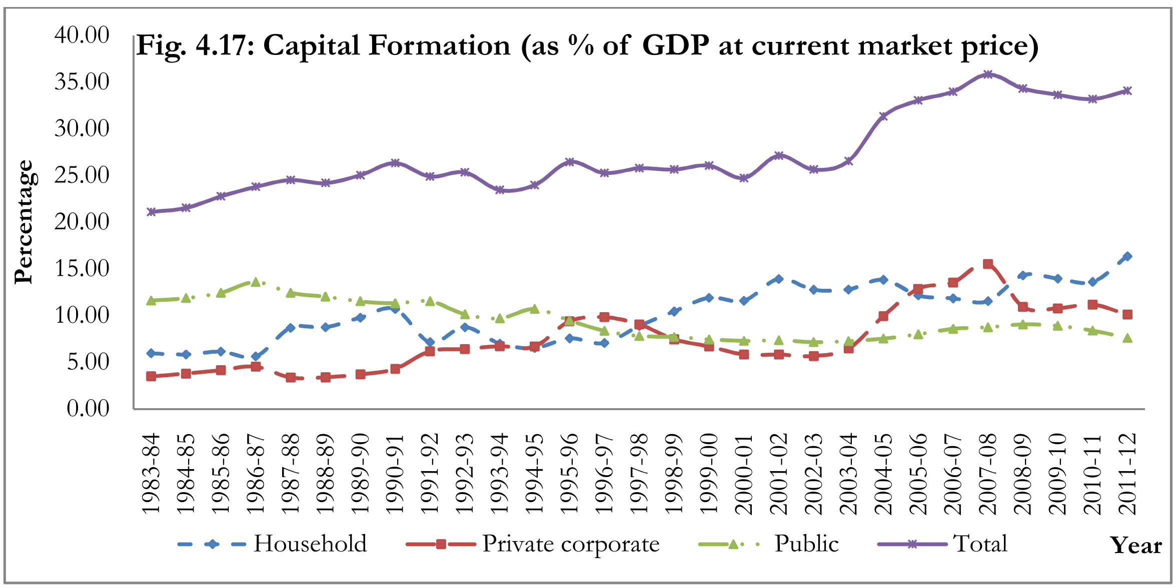
Fig. 4.16: Savings (as % of GDP at current market prices)



Source: Calculated from National Accounts Statistics.

1. Domestic Savings: NAS, Back Series 2011, Statement 10, p. 63; NAS, 2014, Statement 18, p.31.
2. GDP: NAS, Back Series 2011, Statement 4, p. 23; NAS, 2014, Statement 10, p.14.

Fig. 4.17: Capital Formation (as % of GDP at current market price)



Source: Calculated from National Accounts Statistics.

1. GFCF: NAS, Back Series 2011, Statement 11, p. 69; NAS, 2014, Statement 19, p.32.
2. GDP: NAS, Back Series 2011, Statement 4, p. 23; NAS, 2014, Statement 10, p.14.

The trend of change in the rate of capital formation more or less followed the same trend as change in saving rate. Primarily, the rate of capital formation was in the same range as the savings rate up to 2003-04. From 2004-05 there is an increase in the rate of capital formation. The corporate sector investment brings about the surge in the rate from that period (Chaudhuri, 2010)[20].

4.6.4 Intersectoral dependency

The above analysis places the different sectors in the hierarchy of development. As the economy grows, there is scope for structural changes, and the dominance of different sectors play vital role in the sustainability of the changes. The transition from a primitive agrarian economy to a modern industrial society is the unique nature of the growth process. The shift of weights from one to other sectors in the growth process shows the pattern of structural changes. The unbalanced growth process and the structural shift cause considerable changes in production as well as demand linkages. There are weak interdependencies among sectors at the early stages of development, and the production process becomes complex as the economy grows. The analysis of sectoral share clearly shows a shrinking weight of Agriculture and allied activities and the surge of services. The input-output tables are helpful in scaling the changes in the production technique. The input-coefficient matrix or the Leontief matrix gives the picture of underlying technique of production at a certain point of time.

The Leontief inverse depicts both direct and indirect transactions between the sectors. The diagonal elements in the inverse matrix show the degree of self-dependency of the respective sectors. Even after two decades of implementation of liberalisation the sectors are not much integrated with the rest of the economy. The self-consumption coefficients are still large. There is a fall in the value of the coefficient for the agriculture and allied activities and electricity, gas and water supply sector which mean these sectors have become much more integrated and dependent on other sectors. The manufacturing sector also experiences such a fallfor the period. The increase in the dependency of manufacturing sector means the economy move towards the production of more and more sophisticated goods. The increase in the outsourcing and supply chain of the manufacturing goods also have indirect effect on the

[20]See, Chaudhuri (2010).

integration of the sector with other sectors. The Leontief coefficient for the service sector has remained almost constant for the period. The coefficient is still high.

Table 4.7: Forward Linkage Index

	Agriculture and Allied activities	Mining and Quarrying	Manufacturing	Electricity, Gas and Water supply	Construction	Services
1995	0.80	0.59	1.88	0.87	0.54	1.32
1996	0.82	0.60	1.83	0.85	0.55	1.35
1997	0.65	0.44	2.59	0.44	0.20	1.67
1998	0.92	0.69	1.86	1.02	0.65	1.51
1999	0.83	0.69	1.64	0.86	0.60	1.38
2000	0.80	0.72	1.69	0.84	0.62	1.34
2001	0.79	0.70	1.71	0.82	0.62	1.37
2002	0.78	0.74	1.68	0.84	0.62	1.34
2003	0.79	0.70	1.73	0.81	0.61	1.37
2004	0.76	0.73	1.75	0.78	0.64	1.34
2005	0.74	0.76	1.91	0.71	0.54	1.34
2006	0.75	0.74	1.80	0.76	0.63	1.33
2007	0.75	0.75	1.80	0.74	0.63	1.32
2008	0.74	0.75	1.81	0.72	0.65	1.33
2009	0.77	0.72	1.74	0.76	0.65	1.35
2010	0.77	0.73	1.74	0.73	0.66	1.36
2011	0.77	0.76	1.67	0.73	0.66	1.40

Source: Calculated from NIOT published by WIOD.

The calculation of sector wise linkage index reveals that the forward linkage index for the Manufacturing and services sector has been very strong. The forward linkage for the manufacturing sector was 1.88 in the year 1995 which declined to 1.67 in 2011. For other sectors, the linkage index is very low. The strong forward linkage of manufacturing sector means increased dependency for inputs of other sectors on the manufacturing sector. The main contributors to this index are the capital goods industries. The strong manufacturing forward linkage is a favourable change in the input demands. The increasing use of machinery and chemicals in the agricultural activities and inclined roundabout technique in the mining sector helped to the rising input demands of the manufacturing goods. The composition of manufacturing itself has undergone change as the weight of intermediate goods have increased more in comparison to the consumption goods. The forward linkage of services is also strong. As the economy opens up, there is increased transaction with the rest of the world. The sectors like insurance and banking, telecommunication, transport and hotel industry contributed to the growth. So their contribution to supply inputs has grown. Also, the services felicitate the outsourcing process which is very important in the present production structure. (See Table 4.7 for detail)

Table 4.8: Backward Linkage Index

	Agriculture and Allied activities	Mining and Quarrying	Manufacturing	Electricity, Gas and Water supply	Construction	Services
1995	0.71	0.92	1.23	1.03	1.32	0.79
1996	0.69	0.92	1.25	1.06	1.29	0.80
1997	0.35	0.79	1.59	1.02	1.60	0.65
1998	0.78	0.94	1.45	1.14	0.78	0.90
1999	0.73	0.83	1.31	1.09	1.22	0.82
2000	0.73	0.83	1.29	1.11	1.22	0.82
2001	0.73	0.84	1.29	1.12	1.22	0.80
2002	0.75	0.77	1.32	1.12	1.23	0.81
2003	0.73	0.81	1.30	1.13	1.24	0.79
2004	0.74	0.75	1.30	1.20	1.19	0.81
2005	0.66	0.68	1.25	1.15	1.13	1.13
2006	0.72	0.75	1.29	1.25	1.17	0.81
2007	0.70	0.74	1.30	1.28	1.16	0.81
2008	0.69	0.74	1.31	1.30	1.15	0.81
2009	0.69	0.74	1.36	1.24	1.16	0.81
2010	0.68	0.70	1.37	1.29	1.16	0.80
2011	0.68	0.70	1.37	1.30	1.15	0.80

Source: Calculated from NIOT published by WIOD.

The backward linkage gives the demand side of the sector. It is an index which describes the dependency of the sector on the rest of the economy. In this case, there is a strong backward linkage for Manufacturing, Electricity, Gas and Water supply and construction sector. The backward linkage for services sector is intermediate whereas, the indexes are weak for Agriculture and allied activities, Mining and Quarrying. The backward linkage for manufacturing was 1.23 in the year 1995 which increased to 1.37 in the year 2011. The strong demand for inputs by the manufacturing sector is a prime generator of demand in the economy. The agro-based industries depend on the agricultural and allied activities. Also, the uses of more and more service sector in the manufacturing sector keep the index high. Water, Gas and water supply and Construction sector are very dynamic sector after the post liberalisation. It is depended on the other sectors for its output. Manufacturing and Mining sector are major input provider for the construction sector.

The interdependency in the Indian economy is very weak. The manufacturing sector has both strong forward and backward linkage which means it is divided by different industrial groups as some are demand oriented and others are supply oriented.

4.7 Productivity and employment in relation to trade

Much of the literature on productivity growth and technical progress pointed out at Trade liberalisation as a factor of Productivity growth.[21] The system labour productivity (with import coefficient) shows a high growth during the period of study from 1995 to 2011.[22]Goldar (2015) have attributed productivity growth to imported intermediate goods.[23]

The country's growth story should be characterised by the growth of productive labour employment and the absorption of the unskilled labour force. The unskilled-labour-intensive manufacturing has done poorly in India though the reform policy has been adopted. So the future policy should be stressed upon the removal of obstacles to the rapid growth of this sector. The poor performance of this sector in export and majorly the faster growth in the skilled-labour intensive and capital intensive goods had worsened the situation. The industrial structure has been tilted towards the roundabout method of production (Panagariya 2004; Kochhar& et al. 2006). India's export consists of a major part of these products and still the impediments are barring India from exploiting the huge comparative advantage in the unskilled-labour-intensive industries.

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[21] See, Ahluwalia, 1994; Balakrishnan and Pushpangadan, 1994, 1998, 2002; Balakrishnan, 2004; Banga, 2014; Das, 2007; and Panagariya, 2004.

[22] See Chapter 5, Section 5.4.1, Table 5.3

[23]Goldar (2015:110)

The rapid growth and its trickledown effect pull up the majority of poor into the productive employment. The rapid growth in the unskilled-labour intensive sector will create a vast opportunity for employment and also will help in simplifying the burden of the agricultural sector. The comparative advantage in the unskilled labour intensive products and the potential to exploit the international market should motivate the investors in India to risk their resource in those sectors. The domestic policy controls that are effectively obstructing the sector to grow faster and to compete with the world market has to be shackled by the policy makers. A very substantial decline in the share of the agriculture in GDP combined with the stagnant industry share; the created bias towards the capital-intensive industries; slow transition of labour from agriculture to nonfarm activities; again much of the growth in the nonfarm employment has been unorganized; may be featured in slow poverty reduction despite high growth in the reform era. For a sustained growth, India cannot avoid a stage of rapid industrialisation. In the transition period, India must rely upon the manufacturing sector with special mention to the unskilled-labour-intensive manufacturing and the modern services sector.

4.7.1 Trade theories: a literature review

Below is some review of the literature dealing with the broad issue of international trade and growth:

Kaldor(1964)[24] had given his concerns over the composition of world trade. The larger part of the exportsof developing nations consists of primary products. The international market for primary goods expands very slowly as the income elasticity of demand for these products were very low. The situation is so partly due to the low income diverted towards food consumption in the developed nations and also partly due to the fast growing agricultural production and also partly to the economies of production in use of materials in the industry. Thevolumes of trade in manufacturing goods have been trebled while that of for the primary product has been two-third. The author was of the view that the increase in the receipts from export could not be expected to growth more than three percent per annum if the country's export basket were much more dependent on the primary products. Their import requirements are bound to rise faster than their domestic fixed capital formation, and also because income

[24]Kaldor (1964: 493).

elasticities of imports of consumers goods and raw materials were high for the developing and underdeveloped nations. So the high rate of growth of imports could not be maintained unless the growth of exports was to be boosted to at least same rate.Kaldor emphasised that the obstacle to export growth lies on the market side. Theinternational competition restricts the increase in the growth of primary product export. In the initial stages of industrialisation the productivity of labour in manufacturing activities was very low and it rose with the scale of industrial activities, Increase in productivity and lesser costs was partly because of economies of production and mainly because the improvement in skill from learning by doing. So an underdeveloped country needed to put a check on the imports to protect its own manufacturing sector from international competition through protective duties or quota.

The major works on the growth and trade were relied on the economies of scale as the subtheme to explain international specialisation and differences in technology. The little attention paid to increasing returns as a cause of trade wasbecause of the formal trade theories hovered around the different market structure. Krugman (1979)[25] developed a one-factor model in this spirit. The model was concerned with the issues which might give rise to the extension of the market and explained that the extent of the market was caused by growth in the labour force, trade and migration. He argued that if trade were to open up between two countries with identical taste and technology, then the symmetric condition would ensure equal wage rates and equal product prices. Both countries would also have access to the larger labour force. So there would be increase both in scale of production and in the range of goods for consumption. So the model assured trade could take place even if there were no international differences in tastes, technology or factor endowment. This model actually might act as the theory of urban growth as in the presence of increasing returns and free movement of labour would produce a process of agglomeration. People would migrate to the city because of greater consumption variety. So Krugman suggested trade as a simple way of extending the market to exploit the scale economies rather than to go either for growth of labour force or to go for factor migration.

[25] Krugman (1979: 469)

Barker (1977)[26] mentioned two significant features in world trade after world war. There was a substantial growth in world trade relative to that in the production. The second feature being a strong bias of trade towards developed countries and towards the manufacturing products. The surveys of theories related to trade were mostly upon the comparative advantage theory or the factor endowment theory placing greater emphasis to relative prices and costs in explaining international trade. There were other theories like ‘Availability theory’ by Kravis (1956), ‘Demand theories’ Linder (1961).Linder (1961) found countries with similar per capita incomes taste would be more or less same.[27] So the international trade would be dependent upon the intensity of their incomes.

A country tends to import products those are not available at home and availability is dependent on natural resources, the state of technology and product differentiation. Technological progress as cause for the trade is also illustrated by some economists (Posner 1961, Vernon 1966). Product innovation can create a momentary monopoly for one country in exports which are gradually vanished. The demand theories are about the effect of domestic demand factors on comparative advantage. In the presence of Economies of scale and trade barriers across the economy, large economies get a chance to specialise in nationally differentiated goods while small countries specialise in internationally standardised goods.

Tybout (1992)[28] found the returns to the entrepreneurial effort increased with exposure to the international market. The arguments based on the Increasing returns implied a widening of the market through trade leading to decreasing production cost. The effect of liberalisation on productivity was dependent on the specifics of demand shift and the nature of competition. Also the speculative effect of the merger between domestic and the world market had an effect on the productivity. When the substitutions were available, managers preferred labour intensive technology to capital intensive technology even though they were available in less cost in stable market conditions. Rodrik (1992)[29] showed that trade reforms might reduce the rate of convergence to international productivity levels in import-competing sectors and accelerate

[26] Barker (1977: 161)

[27] Linder (1961: Chap. 4)

[28]Tybout (1992: 190)

[29]Rodrik (1992: 98) and Tybout (1992: 191)

among export-competing sectors. Krugman (1985) and Lucas (1993)[30] used the learning by doing externalities at the sector level to create a link between trade policy and sectoral growth patterns. Any policy-induced shift in the composition of output had an effect on the pattern of sectoral learning rates and productivity growth. Grossman and Helpman (1990)[31], in their models argued productivity growth was impelled by private sector research and development, which resulted in new intermediate goods. This addition to intermediate goods augmented forward final good productivity and also contributed to public knowledge.

The trade policy in this frame helps in deciding whether to develop new products when substitutes are already available in the international competition and the mobility of knowledge. The more demand in the extended market for a particular product in a new variety encourages innovation. A change in the trade policy affects the relative output prices, and this induces the rate of returns to new product development and thereby regulates productivity growth.

Frankel and Romer (1999)[32] have empirically investigated the impact of international trade on the standard of living. The research problem has been discussed from Smith's division of labour and extent of the market to the debates of import substitution and export-led growth, to the endogenous growth model. The positive relationship between trade and income may not reflect the effect of trade on income because the trade share may be endogenous or countries with high income may trade more. The positive association between international trade and income is merely because of high-income countries are engaged in more trade.

Although the welfare effect of trade has been vastly debated in the traditional theory, the models are based on the assumptions of allocative efficiency, perfect competition. Also, it has been argued that under trade liberalisation in imperfect markets there will be additional welfare gains by reducing deadweight losses by increasing competition and reducing the price mark-ups. In models of trade and endogenous growth, trade is believed to be an engine of growth. Trade helps in boosting innovation by enhancing industrial learning since it facilitates mobility of technology. Global research only gets better as it illuminates fear of duplication in research.

[30] Krugman (1985), Lucas (1993: 253)

[31] Grossman and Helpman (1990) and Tybout (1992: 191)

[32] Frankel and Romer (1999:379 and 380)

Also, trade via market size effects can negatively affect the incentives faced by domestic producers to innovate.[33] So here it is very much sceptical about the productivity growth after the opening up.

In July 1991, the government formulated trade reforms which ended licence-raj and other non-tariff barriers on imports of intermediate and capital goods and reduced tariffs on imports considerably.[34]Mitra (1999) tested the relationship between trade liberalisation, market discipline and productivity growth.[35] It was found out that there was an increase in competition, a reduction in returns to scale and a weak increase in the rate of growth of productivity post reforms. Mitra and Ural (2007) found that trade liberalisation helped in productivity increase and higher productivity was associated with less protected industries.[36] These effects of protection and trade liberalisation are more pronounced in the states that have relatively more flexible labour markets. Labour market flexibility, independent of other policies, has positive effect on productivity. Importantly, per capita state development expenditure seems to be the strongest and the most robust predictor of productivity, employment, capital stock and investment. Industrial delicensing increases both labour productivity and employment but only in the states with flexible labour market institutions. Even after controlling for licensing, the analysis shows that trade liberalisation has a productivity enhancing effect. Trade liberalisation benefits most the export-oriented industries located in states with flexible labour market institutions. The efficiency of private sector in India is adversely affected by the panoply of rules restricting entry and exit of firms. Such restrictions limit competition faced by existing firms and thus lower firm efficiency. They also prevent firms that are currently inefficient from exiting the market. Thus the productivity of the industry as a whole gets adversely affected. Hall and Jones (1999) argued levels capture the differences in long-run economic performances that are most directly relevant to welfare. Countries in the long-run differ on income levels, not on the growth rates.[37]

[33] Krishna (1998: 448)

[34] Ibid (449)

[35]Mitra (1999: 98)

[36]Mitra and Ural (2007)

[37] Hall and Jones (1999)

Acemoglu, Robinson and Johnson (2001) looked at former European colonies to study the impact of institutions on per capita income levels. For these countries, they are able to use European settler mortality rates as instruments for institutions. In countries conquered by Europeans, whether they decided to permanently settle down or not were determined by their ability to survive there.[38] In case of settling down, they have adopted good institutions.

Melitz (2003) developed a dynamic industry model with heterogeneous firms to analyse the intra-industry effects of international trade. The model confirms how the exposure to trade will induce only the more productive firms to enter the export market and will simultaneously force the least productive firms to exit.[39] Also, it goes beyond to show how increases in industry's exposure to trade lead to additional inter-firm reallocations towards more productive firms. The aggregate industry productivity growth generated by the reallocation contributes to welfare gains. This paper has given an extension to Krugman's trade model that incorporates firm level productivity differences. Firms with different productivity levels coexist in industry because each firm faces initial uncertainty concerning its productivity before making an irreversible investment to enter the industry. Entry into the export market is costly, but firm's decision to export occurs after it gains knowledge of its productivity.

The study of growth can be divided into growth in labour productivity and the increase in the productive labour in the total population. So the labour productivity growth and employment growth determines the pace and direction of growth. Post-reforms, there has been growth in labour productivity, but that of the growth in employment has not been up to the mark. So jobless growth has been the core issue of debate in every policy and programme formulation. Much of the growth in employment in recent years has taken place in the unorganised sectors. Also, there has been growing informal employment in the organised sector. Thus regarding the quality of employment generation also we lack behind. For achieving inclusive growth, there is a need to generate more employment in non-agricultural sectors so that more and more workers can be transferred to those high productive sectors. The radical changes due to international trade orientation are expected to have a major impact on the employment situation. The chapter

[38] Acemoglu, Robinson and Johnson (2001)

[39] Melitz (2003)

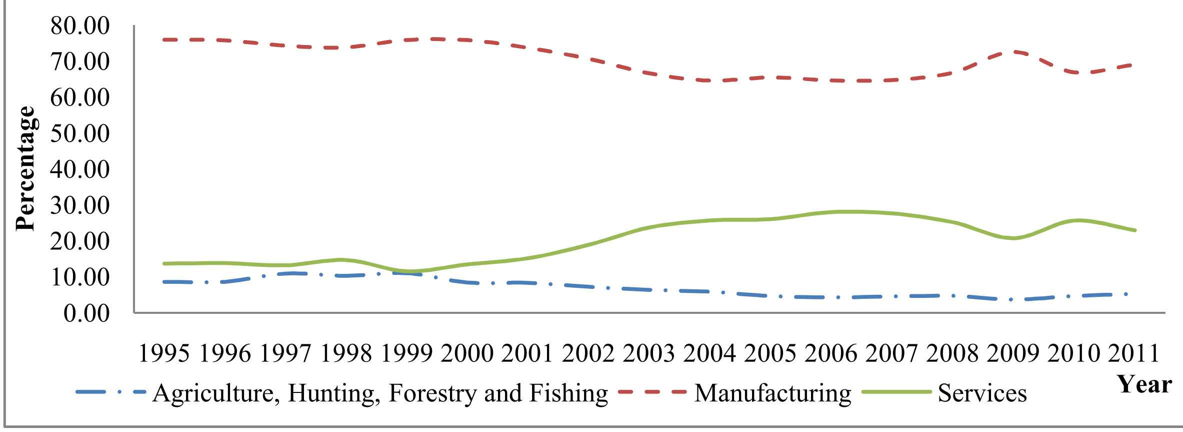
intends to examine the possible effects on employment due to trade, change in demand and change in technology.

4.7.2 Composition of trade

In the post-reforms period, the export and Import have been growing, but what matter the most is the composition of export. Kaldor had given his concerns over the composition of world trade. The larger part of the exports of developing nations consists of primary products. The world market for primary commodities expands only slowly, owing to the low-income elasticity of demand. This is partly due to the low-income elasticity of food consumption in the wealthy nations by partly due to the rapid growth of their own agricultural production and partly to the economies in use of materials in the industry. The volumes of trade in manufacturing goods have been trebled while that of for the primary product has declined to two-third. If the primary exporting regions were to continue to depend mainly on the exports of primary products, their export receipts to the outside world could not be expected to increase by more than three percent per annum. Their import requirements are bound to increase faster than their domestic fixed capital formation, even though their own income elasticities of imports of consumer goods and raw materials are high. So the high rate of growth of imports cannot be sustained unless the rates of growth of exports are to be stepped up to at least the same rate.

A look into the share of indicates that the manufacturing sector has dominated. It constitutes around 75.8% in 1995 which has declined slightly to 69.01% in 2011. Within the manufacturing, the major contributors are the textile product, chemical product, basic metal product, non-metallic mineral product and recycling & manufacturing nec. at the start of the study period. However, the share of textile, chemical product and the non-metallic mineral product has declined steadily. Electrical machinery, transport equipment, basic metals product and recycling & manufacturing nec., dominated the export share of manufacturing at the end of the study period. The export share of services has increased from 14% to 23%, and that of agriculture & allied sector has declined to only 5% of the total export.

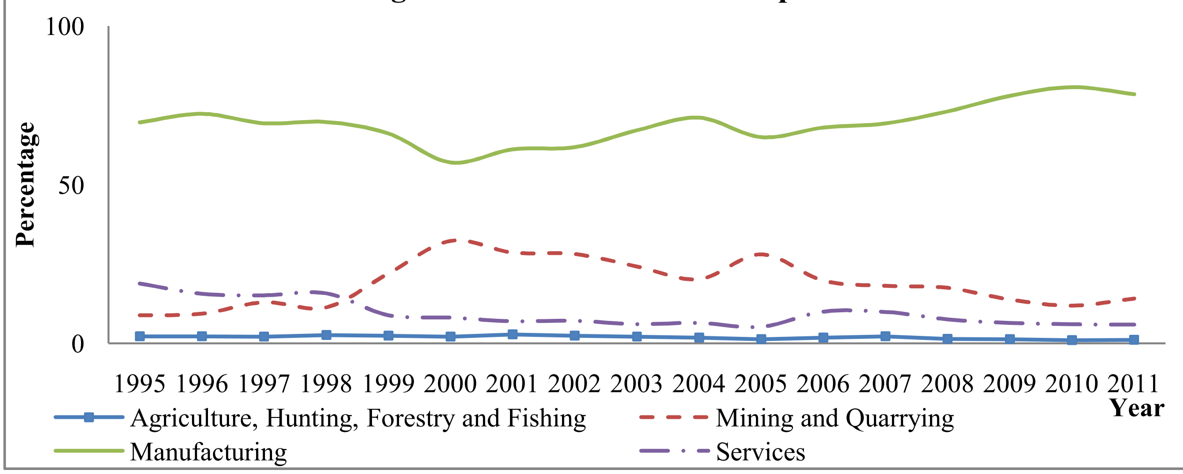
Fig. 4.18: Sectoral Share in Export



Source: Calculated from Export data collected from I-O table published by WIOD for India.

Note: All Values are in current prices.

Fig. 4.19: Sectoral Share in Import

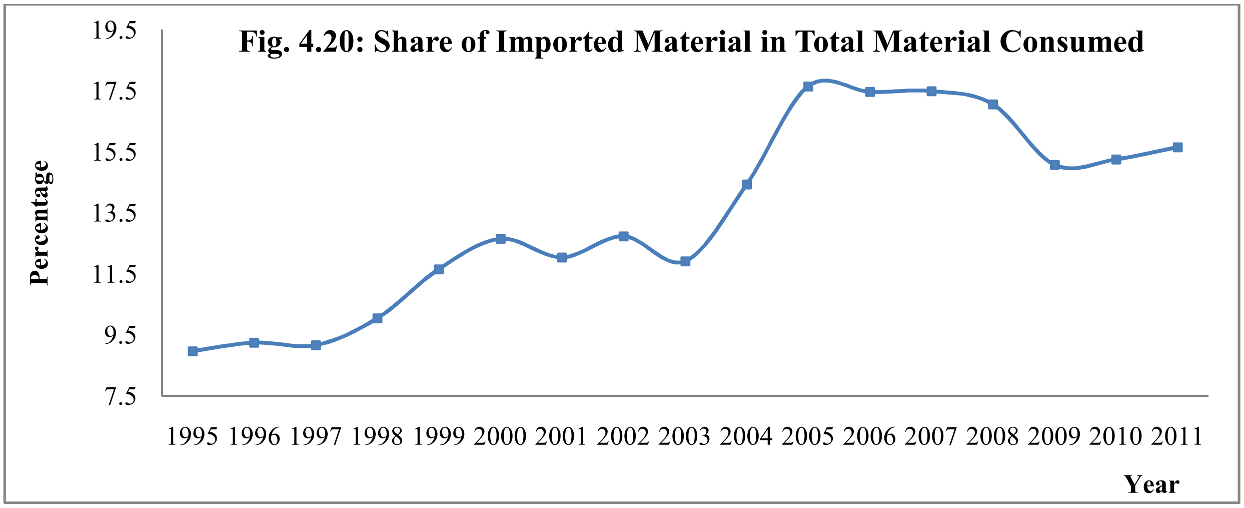


Source: Calculated from Import data collected from I-O table published by WIOD for India.

Note: All Values are in current prices.

Apart from being the major exporter, manufacturing also dominated the import share. It increased to 78.6% in 2011. In the post-reform period, the import share of services declined from 18.8% to 5.88% in 2011. Import share declined in all sectors other than the mining and quarrying. The major importing manufacturing sectors are the recycling & manufacturing nec., basic metal product, electrical machinery and chemical products.

Fig. 4.20: Share of Imported Material in Total Material Consumed



Source: Calculated from Import data collected from I-O table published by WIOD for India.

Note: All Values are in current prices.

A major concern is that there is an increased use of imported material in the total material consumed. It increased from 8.95% in 1995 to 15.6% in 2011. So increased dependency on the imported goods for production may lead to increase in production but not due to own labour productivity.

4.7.3 International trade and employment

The rapid growth in the unskilled sector will create a vast opportunity for the employment and also will help in simplifying the burden of the agricultural sector. The comparative advantage in the unskilled intensive products and the potential to exploit the international market should motivate the investors in India to risk their resource in these sectors. The domestic policy controls that are effectively obstructing the sector to grow faster and to compete with the world market has to be shackled by the policy makers.

To locate the effect of trade on employment, a simple decomposition method is applied. The basic equation is given below- [40]

$$\frac{\dot{L}}{L} = \frac{\dot{Y}}{Y} + \frac{\dot{l}}{l}$$

[40]Goldar (2009: 5-7).

Where L denotes labour (employment), Y denotes output; l denotes labour per unit of output (inverse of labour productivity). The growth of labour employment is the sum of the growth rate in output and growth rate in employment per unit of output.

Trade affects employment growth through its impact on the growth rate of output and the growth of employment per unit output. Rapid growth in exports in industry, we raise the growth rate of output in the industry and thus contribute to employment generation. But it may simultaneously reduce the labour intensity in production because of more use of roundabout technology of production.Thus reduces employment growth. An increase in the export orientation of an industry may be associated with changes in the product mix in favour of labour intensive products causing labour intensity to goes up. A rapid increase in imports of a product may have an adverse effect on the output of the competing domestic industry and thus have an adverse effect on the employment growth. Import competition may force the inefficient firms to quit and compel many other firms to introduce more mechanised methods of production both of which may have an adverse effect on labour intensity and hence on employment growth.

$$E_1 - E_0 = (C_1 - C_0)l_0 + Q_1(l_1 - l_0) + (X_1 - X_0)l_0 + (M_0 - M_1)l_0$$

E= employment

C=domestic consumption

M=imports

X=exports

$(C_1 - C_0)l_0 = Impactof\ increaseindomesticdemandonchangeinemployment$

$Q_1(l_1 - l_0) = effectofchangesinlabourintensityonchangeinemployment$

$(X_1 - X_0)l_0 = Impactofexportexpansiononchangeinemployment$

$(M_0 - M_1)l_0 = ImpactofIncreaseinImportonchangeinemployment$

Table 4.9: Decomposition of Change in Employment (in numbers)

	1995-1999				1999-2004				2004-2011			
	$(C_1 - C_0)l_0$	$(M_0 - M_1)l_0$	$(X_1 - X_0)l_0$	$Q_1(l_1 - l_0)$	$(C_1 - C_0)l_0$	$(M_0 - M_1)l_0$	$(X_1 - X_0)l_0$	$Q_1(l_1 - l_0)$	(C1-C0)l0	$(M_0 - M_1)l_0$	$(X_1 - X_0)l_0$	$Q_1(l_1 - l_0)$
Agriculture and allied activities	233637	-3291	13975	-241698	103967	-2423	4562	-87604	929370	-10028	45091	-986352
Mining and Quarrying	7501	-4916	228	-3212	9621	-5741	1394	-4986	17550	-8953	1637	-11038
Manufacturing	25432	-4385	4639	-22695	53428	-11523	9093	-38901	161055	-38828	29695	-139244
Electricity, Gas and Water Supply	1007	-3	0	-1236	570	-3	0	-394	2380	-13	0	-2186
Construction	26884	-38	0	-23363	33024	-20	0	-24543	102770	-97	0	-91503
Services	107894	-283	1818	-100269	87824	-1559	10203	-76502	378427	-6052	20463	-371740

Source: Author's calculation. I-O tablespublished by WIOD for India are used.

Deflator used: GDP deflator, Base Year: 2004-05 prices.

In this section, to make the decomposition analysis of the effect on employment 4 I-O tables from WIOD for India are taken. The I-O tables are for the years 1995, 1999, 2004 and 2011. So here the author wants to analyse the trend of the effect on employment due to change in domestic demand, due to change in labour coefficient and due to change in export & import in between the periods selected.

The change in employment is positive, but the rise is at a declining rate as analysed in the earlier sections of the chapter. The change in total employment was around 1.76 crores during the period 1995 and 1999. In the next period it was around 5.95 crores, and in the end period, it has declined to 2.24 crores. In the 1st phase, the major contributors are the service sector, agriculture & allied sector, food & Beverages, wood product. The significant increase in agriculture & allied activity, textile sector, non-metallic mineral product, recycling & manufacturing nec., construction and services sector. The third & final phase sees a negative contribution from agriculture & allied activity. Apart from this, the other rising sectors have an increasing employment.

There is a positive effect of enlarged domestic demand and export on employment. But the increased import and declining labour coefficient have a negative effect on employment generation. The agriculture & allied activity, manufacturing & services have benefited from the rising domestic demand & increased export. But mining, electricity gas & water supply and construction are much dependent upon the enlarged domestic market. The increase in the export in case of manufacturing sector gives a clear idea that export has a positive effect on employment generation. The export of products from food & beverages, textile, wood, basic metal, electrical machinery and manufacturing nec., and recycling has a great effect on employment. Within the manufacturing, the major contributor to employment gain due to enlarged domestic demand are food & beverage, textile, wood product, non-metallic mineral product and basic metal products.

Due to increased use of labour saving technology the labour coefficient has declined. This has a negative effect on the employment. So does the increase in the import results in decline in employment. The effect of a change in labour coefficient gives the displacement effect of technology on the employment. The major decline in employment due to change in labour intensity would be in the Agriculture & allied, Services, Construction, Food Processing, TextileProduct, Wood product, Basic metal product and manufacturing nec., and Recycling. The negative employment effect due to increasing import would be more in Agriculture & allied activities, Mining and Quarrying, Basic and non-ferrous metal product and Manufacturing nec., and Recycling.

4.7.4 Decomposition of change in employment by composition of export

The composition of trade plays a strategic role in employment generations through trade. The shift from a primary economy to a capitalist developed economy also brings in changes in the composition of trade. The export of the developing nations consists of primary products and due to low-income elasticity for these products the receipts from exports do not raise much. But the requirement for imports grows at the comparatively high rate. The Indian merchandise trade is dominated by the manufacturing sector both in imports and exports. The rise in the export of the labour intensive product should have a much larger multiplier effect on employment. The studies on global production networks also suggest that India should increase its production of labour intensive products and should specialise in these productions. So the composition of trade entails the production techniques and production process of the economy. The effect of the composition of export on employment is analysed below.

Table 4.10 gives a demonstration of effect on employment due to change in the composition of export. The export share has changed during the period for a different sector. The counterfactual value of export gives the value of export it would have been if there is no change in the export share i.e. the export share would remain the same as in 1995. So the difference in employment needed to support the actual export and the counterfactual value of export gives the figure of employment if there is no change in export composition. From the table, it is clear that the actual employment needed to support the actual export is 30843.9 thousand but if there is no change in export share, then that would have fetched 41704.3 thousand employment. So the change in trade composition results in a loss of around 1.08 crore employment. So the trade composition should be such designed that would generate more employment.

Table 4.10: Employment Effect of Changes in Composition of Export							
	Share in Export (in Percentage)		Value of Export (in Million Rs.)		Labour Coefficient in 2011	Employment Needed (in Thousand)	
	1995	2011	2011	Counter-factual		2011	If no Change in Share
Agriculture & Allied Activities	8.52	5.17	813008.1	1340668.9	0.007	5486.9	9048.0
Mining and Quarrying	2.03	2.93	460146.7	319570.9	0.000	147.2	102.2
Manufacturing	75.86	69.01	10855839.6	11932456.0	0.001	8797.5	9670.0
Electricity, Gas and Water Supply	0.00	0.00	437.0	1.3	0.000	0.1	0.0
Construction	0.00	0.00	0.9	-0.8	0.001	0.0	0.0
Services	13.59	22.89	3600636.0	2137372.1	0.001	4814.3	2857.8
Total			**15730068.3**			**30843.9**	**41704.3**

Source: Author's calculation. Data collected from the I-O tables for respective years published by WIOD for India.

Deflator: GDP Deflator, Base year: 2004-05.

Note: Counterfactual value of export is computed by applying share in 1995 to the total value of export in 2011.

4.7.5 Vertical specialisation

One of the major export promotion policies is to integrate the domestic industries with the global production networks.[41] India has an intrinsic comparative advantage in the production of labour-intensive products as well as components, but it has remained at the back foot when it comes to vertical specialisation even after two decades of opening up. The share of parts and components in manufacturing trade in both exports and imports of India was much lower than the world average and also the Asian countries (Athukorala 2012). The study also resembles the fact that India's intermediate imports have gone up during the post-liberalisation period.

In this study, the author has used the index of vertical specialisation proposed by Hummels et al. (2001). This index gives the share of imported intermediates embodied in a country's exports.

$$VS_k = uA^M[I - A^D]^{-1}\, X/_{x_k}$$

Where u is 1*n vector of 1's, A^M is the n*n imported coefficient matrix, A^D is the n*n domestic coefficient matrix, I is the identity matrix, X is an n*1 vector of exports, x_k is the aggregate value of exports from country k.

The Heckscher-Ohlin model of international trade explains the specialisation patterns of the countries according to the relative factor endowment. A country will specialise in a product which makes intensive use of factors that are abundant in the country. Several studies show compared to high-income and middle-income countries India is relatively scarce in capital and skilled labour (Cadot& et al 2009; Barro& Lee 2010). India has comparative advantage in the industries which use unskilled labour intensively. Veeramani (2013) estimated India's share in world market in labour intensive product was only 2% in 2008. While the share of capital intensive goods and technology intensive goods in its merchandise export have increased. The

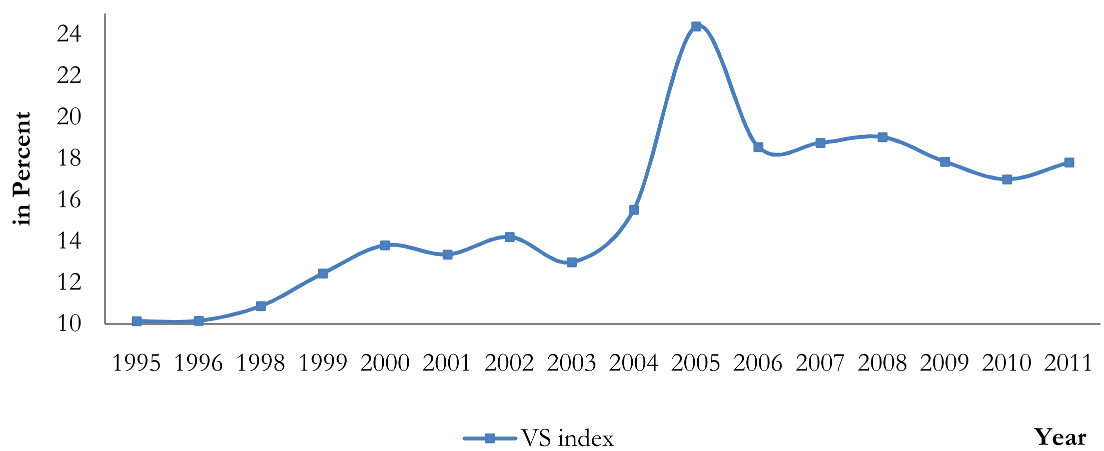
[41]Global production networks refer to the links between a lead or a key firm and its suppliers in different countries. The subdivision of a production process into different stages in certain industries makes the production process costs less. The fragmentation of the process of production into more specialised components allows the entrepreneur to exploit the advantage of factor endowments in different countries. Vertical specialisation has been an important factor in the East-Asian miracle. Fall in the world-wide tariff barriers; expansion of transportation networks; and production sharing and interdependence of multi-national firms are some of the causes of increasing global production networks.

For details see Weiss (2005, 2011), Athukorala and Yamashita (2006), Veeramani (2013, 143).

changes in the export combination effects employment as well. So in the liberalisation era, to counter the problem of jobless growth vertical specialisation policy comes handy.

Using the above index for vertical specialisation the import content of India' export is estimated. The value of the index increased from 10.12% in 1995 to 17.81% in 2011. There has been a steep increase in the vertical specialisation in the year 2004 and 2005. But it fell in the next year. The values of vertical specialisation index are estimated by OECD for countries like Korea Republic, Taiwan, Thailand, China are greater than that of India.

Fig. 4.21: Vertical Specialisation Index



Source: Data collected from the I-O tables for respective years published by WIOD for India.
Deflator: GDP Deflator, Base year: 2004-05.

India’s inward FDI was primarily horizontal which is directed towards capturing the domestic market. OECD investment policy review observes, ‘despite the government’s intension of promoting export-oriented FDI project, the main objective of foreign investors in India was domestic market seeking’ (OECD 2009). Kruger (2010) has also pointed out India’s failure to use India as an export platform in un-skilled labour intensive industries.

India's export basket is tilted towards capital intensive and skill intensive product in contrast to the country's comparative advantage lies in labour-intensive sectors. The stringent labour laws discourage FDI to flow in labour intensive sectors. The import substitution policies are still predominant and could not be overcome by the 1991 policy changes. A flexible labour market is a necessary condition to increase the growth of labour-intensive exports. India has been locked out of vertical specialisation mainly because of relatively high tariff rates; inefficient infrastructure; problematic land acquisition etc. looking at the employment generation capacity of trade, the exploitation of comparative advantage through vertical specialisation should be encouraged. Veeramanai (2013) suggested a deliberate strategy of promoting greater integration with global production networks will help in shifting of unskilled labour from primary sectors to secondary sectors. The low vertical integration of India's export is one of the causes of not getting the employment generation as expected. The vertical specialisation also will help in increasing the productivity of labour in labour intensive sectors.

4.8 Summary

The results as discussed above demonstrate that the labour productivity growths for different sectors are high during the period of study. The divergence between growth in the productivity of organised and unorganised sector in the post reforms period has been increasing. The labour productivity overall is found to be very low for the unorganised sector in comparison to that of organised sector. As much of the employment is generated in the unorganised sector, the steady growth in the unorganised sector is very important. Construction achieved the highest productivity growth. The capital-intensive manufacturing sectors have performed very well as compare to the labour intensive sectors. The capital intensity grew very high in all the sectors and here too the capital intensive sectors performed well.

From the case study on Indian organised manufacturing using the ASI data, it is found that the growth and trend of labour productivity in the post liberalisation period have been increasing. The roundabout methods of production and high degree of demand for these products have been the driving force behind the productivity growth. The increasing returns to scale, the use of roundabout production process, and introduction of new machinery, demand dependency, privatisation and inflow of investments are the main causes affecting productivity growth. Verdoorn’s law and Kaldor’s Technological Progress function combined together explains the productivity growth for the Indian registered manufacturing. The operation of the increasing returns to scale in the factor employment has played a significant role in determining the size of productivity. The elite industries employing larger labour or larger capital have enjoyed an upper hand in the productivity rise. These elite factories have a larger increase in productivity compared to their other counterpart. In the period of liberalisation, the corporate enterprises have grown at a rapid pace which hints at the operation of scale economies.

The structural change in the economy can be emphasised through shift in dominance to service sector from agricultural sector. But the linkage index shows manufacturing being the basis sector of the economy. The interdependency observed between the sectors for the inputs have been important in the production structure. The interdependency of the sectors also affects the productivity levels.

The increased use of capital-intensive technology and increased use of imported materials in the production function has negative effect on the employment growth. Much of the employment growth depend upon the increase in the domestic demand and export increase. If these two factors rise in the labour-intensive sectors, then it would help in generating more employment. Also in the era of globalisation, the trade composition has to be taken care of very carefully to generate ample employment. The external sector has a very prominent role to play in employment generation. India lags behind the other contemporary economies in exploiting the comparative advantage in the unskilled labour intensive sector. The low vertical specialisation of the economy obstructs the trade specialisation process.

The labour productivity measure discussed in the chapter is unable to catch up the inter-linkage between sectors. In the next chapter, an alternative to the direct labour productivity index will be discussed to take care of inter-linkages.

Appendix

A 4.1 Database and period of study

The data of the study is collected from the different issues of the National Accounts Statistics published by Central Statistical Organisation (CSO). The employment data for different sectors are taken from NSSO reports on employment and unemployment situation in India for different rounds (1983-84, 1993-94, 1999-00, 2004-05, 2009-10, 2011-12). The employment data for the different organised sector is taken from different issues of the 'Economic Survey'. The original source for the data on employment is Directorate General Employment and Training (DGE and T). Also, National Input-Output Table published by WIOD is also used for the period 1995-2011. For Registered Manufacturing, NVA, Total person engaged, and Fixed capital data are taken from Annual Survey of Industries for the period 1983-84 to 2011-12.

In this chapter, the concerned period is 1983-84 to 2011-12. The study period taken for the study can be divided into two parts. 'India was still a highly controlled economy in the 1980s, but the direction of movement during that decade was unambiguously toward greater liberalisation. The controls introduced during the 1970s being extensive and the pace of liberalisation in the 1980s piecemeal; India still looked highly controlled in 1991 when measured against a conventional market economy. Nevertheless, the change at the margin had been toward liberalisation and the policy regime in 1991 was significantly more liberal than in the late 1970s (Panagariya, 2010).'[42] So the first phase is from 1981 to 1990 and the second phase starts from 1991 onwards. But in our study to make concordance with the NSSO employment data, the first phase is from 1983-84 to 1993-94 and the second phase starts from 1993-94 to 2011-12.

A 4.2 Methodology

In this chapter, the analysis deals with the trends in the sectoral growth rates and sectoral share. The sectoral shares are as usual calculated as ratio between sectoral values to total aggregate value.

Growth rates

The annual growth rate is the growth of that variable on an annual basis. It is calculated as follow:

[42] Pangariya (2010: Chap 1).

$g_t = \frac{y_t - y_{t-1}}{y_{t-1}}$, g_t = annual growth rate, y = variable, t = time.

The growth rates are compound annual growth rates (CAGR). It is calculated as follows:

$$Growthrate = [\{(endvalue/initialvalue)^{\frac{1}{n-1}}\} - 1] * 100$$

The trend growth rate is calculated by fitting a semi-log regression line. The equations estimated are of the form: Log (Y) = a + bT, here Y is the variable, and T refers to the number of years in the period for which the growth rate is calculated. Then in the second step, antilogarithm of the relevant coefficient minus one gives us the growth CAGR.

A 4.3 Linkages

In an input-output framework a producing sector purchases outputs of different sectors as inputs and sells to them its own output as input. Sectors are thus interlinked through purchases and sales of their output. Transactions differ from sector to sector and for a particular sector time to time and the intersectoral relatedness varies both in nature and in degree. To account for such variation in inter-relatedness Hirschman and Rasmussen have developed the concept of Linkage. A linkage index describes the degree of interdependence among the producing sectors in the economy. Hirschman in his strategy of unbalanced growth values investment decisions not only because of their immediate contribution to output but because of the larger and smaller impulses that it generates on the others.

A sector performs two types of intersectoral activities input purchasing and output distributing. A sector's input linkages describe how it depends on other sectors for its input, while its distribution linkages exhibit the dependence of other sectors on its own output for their resources. The importance of a sector to other sectors is judged by distribution (forward) linkage while the importance of others to it is revealed by input (backward) linkage.

The elements of the input coefficient matrix (A) indicate only the direct requirement per unit of output while the elements in the Leontief inverse give both the direct as well as indirect requirement per unit of output. Rasmussen (1956) while studying the structural changes in Denmark had used the measure of industrial linkage from Leontief inverse.

Backward linkage index: Backward linkage of a sector shows the relationship between the activity in the sector and its purchases. Backward linkages are defined as

$B_l = u(I - A)^{-1}$

Where, u is the unit vector and B_l is the vector for backward linkages. So backward linkages are the column-sums of the Leontief inverse.

$$B_l = \left[\sum_{i=1}^{n} \alpha_{i1}\ , \sum_{i=1}^{n} \alpha_{i2}\, , \sum_{i=1}^{n} \alpha_{i3} \dots \dots \sum_{i=1}^{n} \alpha_{in}\right]$$

Backward linkage index for j^{th} industry is defined by te ratio of average of j^{th}-column average of Leontief inverse to the total average.

$$B_{li}{}^{j} = {}^{\sum_{i=1}^{n} \alpha_{ij}}/_{n} \Big/ {}^{\sum\sum \alpha_{ij}}/_{n^2}$$

Here the numerator is the j^{th} column average and the denominator is the total average.

Forward linkage index: Forward linkage depicts the relationship between the total output of a sector and the sale of its output as intermediate inputs to the other sectors. Forward linkages are defined as, $F_l = (I - A)^{-1} u'$

Where, F_l is the vector for forward linkages and u' is the transpose of unit vector.

The forward linkages are the row-sums of the Leontief inverse.

$$F_l = \left[\sum_{j=1}^{n} \alpha_{1j}\ , \sum_{j=1}^{n} \alpha_{2j}\, , \sum_{j=1}^{n} \alpha_{3j} \dots \dots \sum_{j=1}^{n} \alpha_{nj}\right]$$

The forward linkage index for the i^{th} industry is determined by the ratio of average of i^{th} row-sum of Leontief inverse to total average.

$$F_{li}{}^{I} = {}^{\sum_{j=1}^{n} \alpha_{ij}}/_{n} \Big/ {}^{\sum\sum \alpha_{ij}}/_{n^2}$$

Here the numerator is the average of the i^{th} row-sum of Leontief inverse, and the denominator is the total average.

Basing on the values of the indexes the interdependencies can be divided into three categories as strong, intermediate and weak. If the linkage-index is greater than 1 (LI>1) i.e. if the row-wise averages or column-wise averages are more than total average, then there is a strong dependency. If the linkage index lies between 1 and 0.8 then it is categorised in intermediate (1>LI>0.8). If the linkage index falls below 0.8, then the integration is weak (LI<0.8).

A4.4 Ratios used in the study

The main ratios used in the study are labour productivity, capital intensity. *Labour productivity* is defined as the real net value added per person engaged. The ratio is adjusted for inflation by deflating the net value added by implicit GDP deflator at 2004-05 prices.

$$LabourProductivity\ (LP) = \frac{NetValueAdded\ (Real)}{Totalpersonengaged}$$

Capital intensity is defined as fixed capital per person engaged. The fixed capital used in this study is real and is deflated by GDP deflator at 2004-05 prices.

$$CapitalIntensity\ (K/_L) = \frac{Fixedcapital}{Totalpersonengaged}$$

A 4.5 Jobless growth in registered manufacturing

The manufacturing sector is very important in the field of employment generation and absorption of abundant non-skilled work force. The changes in the occupational structure i.e. shift of employment from primary to secondary then to the tertiary sector explains the process and characteristics of growth. In the post-independent India, the agriculture and allied sector comprised of the majority of employment around 49 % in 2011. During this period the share in manufacturing sector remained almost constant at 14 %. On the other hand the organised manufacturing sector, the employment growth was a negative 0.17 % per annum, and that of the share is around 23 % during the period of study.

Although the total person engaged in the organised manufacturing is rising, the growth rates are not uniform during the period of study. Job security regulation, sharp hike in real wages, capital deepening strategy, and less labour intensive industries have contributed to slow employment growth (Goldar, 2000). A lessening of labour market rigidity and introduction of industrial dispute act caused late revival during recent years (Goldar, 2011). Mainly four causes for inadequate employment growth have been identified. First, the nature of transition from inward looking regulating economy to an open competitive economy has resulted in job losses in inefficient enterprises: second, there is a sharp shift to capital-intensive technique: third, presence of inappropriate labour market regulation affecting labour cause and labour movement: and finally, the wage elasticity of registered sector labour market happened to be the causes of comparatively low employment growth (Dasgupta and Singh, 2005). In the present section, the degree of jobless growth is examined.

From the Table A4.3, we get the "β" coefficient which gives the elasticity of employment to the change in output. The co-efficient indicates whether the change in output affecting the change in employment and also gives a degree of response to the change. It is found that the "β" coefficient is only '0.22' during the period of study. The t-statistics confirms the significance of the parameter. The value suggests that if there is a change of Rs.1 lakh of value added, the employment changes only by 0.22.The breaks in the study period suggest that the employment growth in response to the value added growth was very slow (0.03) during the pre-reforms period. It improved during the post-reforms period. During the 2nd phase of post-reform i.e. from 2001-2013, the elasticity is found out to be 0.45. We may find some of increasing elasticity of employment in manufacturing sectors although it is still very small. This suggests a prevalence of jobless growth in the manufacturing sector.

Alternative Approach to Measurement of Productivity-II (System Labour Productivity)

5.1 Introduction

In Section 4.6 of the previous chapter, the interdependency among the sectors has been analysed. The very nature of the production system of the economy is bound to affect the productivity level of the sectors. The simple labour productivity measure does not capture the inter-sectoral dependency. In the analysis presented there, labour productivity means direct labour productivity or industry labour productivity.

> In the absence of an economic theory giving a straightforward interpretation of all these outcomes the attention of economists has been called back more and more to changes in technology; and economic statisticians, in trying to evaluate these changes, have followed the easiest way: they have normally taken ratios of production to man-hours (labour productivities) and computed their changes through time. The procedure is very useful for many purposes but, among other limitations- for example, the impossibility of taking into account qualitative improvements- it has the major defect of referring only to labour, while the production process involves as well other factors of production whose productivity might change in different way. This leads to different conclusions as to the productivity of the system as a whole. (Pasinetti, 1959: 270)

It was realised that the industry measures cannot deal with the interdependent nature of technical change.[1] When the whole economy is considered as an interlinked system, the industry labour productivity could not represent inter-sectoral transactions and may overstate the labour productivity. This is captured by system labour productivity. The present chapter therefore takes up 'system labour productivity' as an alternative concept and measure of productivity in line with classical development economics. It is designed to incorporate the interlinked system.[2]

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[1] See Garbellini and Wirkierman (2013: 154)

[2] Industry labour productivity is the reciprocal of the labour coefficient in the input-output transaction tables. Value added as the proxy for output should be used in a measure for labour productivity but to make compatible with the system labour productivity (which makes use of the Leontief inverse) gross output is taken as the output measure. The trend of gross value added and the gross output is examined and is found to be same for all the sectors. There is a parallel gap between the two.

Section 5.2 gives an account of trend and growth of industry labour productivity. The sections followed i.e. Section 5.3 and Section 5.4, present the concept of system labour productivity and its implications. The issue of decreasing labour content and its relationship with labour productivity is established. Section 5.5 deals with the employment implication of the system labour productivity measure. A brief conclusion to the chapter is followed in Section 5.6. National Input-Output Table for India and Socio-Economic Accounts published by WIOD is the data source for the chapter. In the last chapter, industry productivity is being discussed with the use of NAS and ASI database. This chapter also includes the discussion on industry labour productivity with a different database i.e. National input-output table by WIOD and with different variable of output. As the system labour productivity can only be calculated using input-output table, for comparison industry labour productivity is also calculate using the same database. The period of the study was chosen on the basis of data availability. The period of study is restricted to 1995 to 2011. In section 5.2, due to data constrained for the labour compensation the analysis in this section is limited up to the year 2009. From the analysis presented in the chapter, it will be found that there is an increase in both industry and system labour productivity for each of the sectors. The growth in the system labour productivity is higher than that of the industry labour productivity in labour intensive manufacturing sectors like Textile, Leather, Wood product, Paper product, and recycling manufacturing. The elements in ‘direct labour use' and ‘system labour use' vectors are declining. The sectors mentioned above tends to use more of the produced inputs which causes the total labour use to fall. Also, it was found that the employment potential of the labour intensive sectors has to be exploited to get more employment generation.

5.2 Trends in industry labour productivity

In the previous chapter, the Industry labour productivity is dealt with. This section aims to look at Industry labour productivity using the WIOD data on input-output transaction and socio-economic accounts to facilitate comparison between System labour productivity and Industry labour productivity using a uniform data set.

From Figure 5.1, the trend of labour productivity can be observed for different broad sectors. For the Agriculture and allied activities, the productivity has grown over the period 1995 to 2011. In the year 1995, the value of productivity in the agriculture and allied sector was 10.68 million rupees per person engaged which increased to 148.17 million rupees per person engaged in the year 2011. The trend of productivity in this sector also demonstrated an increased rate of growth after the year 2003. For the mining and quarrying sector, the labour productivity in the year 1995 was 59.61 million rupees per person engaged which has increased to 3125.83 million rupees per person engaged in the year 2011. The trend for this sector demonstrated a rapid surge in the productivity after the year 2003.

For the manufacturing sector as a whole, the productivity was 158.12 million rupees per person engaged in 1995, and this increased to 1233.96 million rupees per person engaged in 2011. There was an increased rate of productivity growth for this sector after the year 2003. Analysis of Labour productivity of individual sectors revealed that the productivities of labour intensive units were very low compared to that of capital intensive units. While food product, textile, leather, wood product, paper product, non-metallic mineral products, manufacturing nec., and recycling demonstrated very low productivity, other sectors like rubber plastic and petroleum product, chemical, basic metal product, electrical machinery, transport equipment performed well during the period under study. Recently, transport equipment, basic and non-ferrous metal products, however, achieved their highest productivity levels. (See Table A5.1 in Appendix of the chapter)

There was also a sharp increase in the productivity levels of electricity gas and water supply and the construction sector. The productivity of electricity gas and water supply increased from 510.64 million rupees per person engaged in 1995 to 3815.94 million rupees per person engaged in the year 2011. Likewise, the productivity in the construction sector increased from 55.09 million rupees per person engaged to 864.86 million rupees per person engaged during the same period. Unlike the other sectors, there was no break in the trend in these two sectors after the year 2003.

Services sector also gained in productivity level in the post-reforms period. The output of this sector grew tremendously in the concerned study period and there was comparatively slow growth in the employment. So the productivity level increased from 57.37 million rupees per person engaged in 1995 to 747.90 million rupees per person engaged in the year 2011.

The growth rate of output can be decomposed into labour productivity growth and the growth in employment, so the problem of low growth can be solved either by increasing productivity or by increasing the employment. Here in Table 5.1, the growth of labour productivity is presented as output growth and employment growth.

Table 5.1: Decomposition of Industry Labour Productivity Growth (1995-2011) (in Percent)

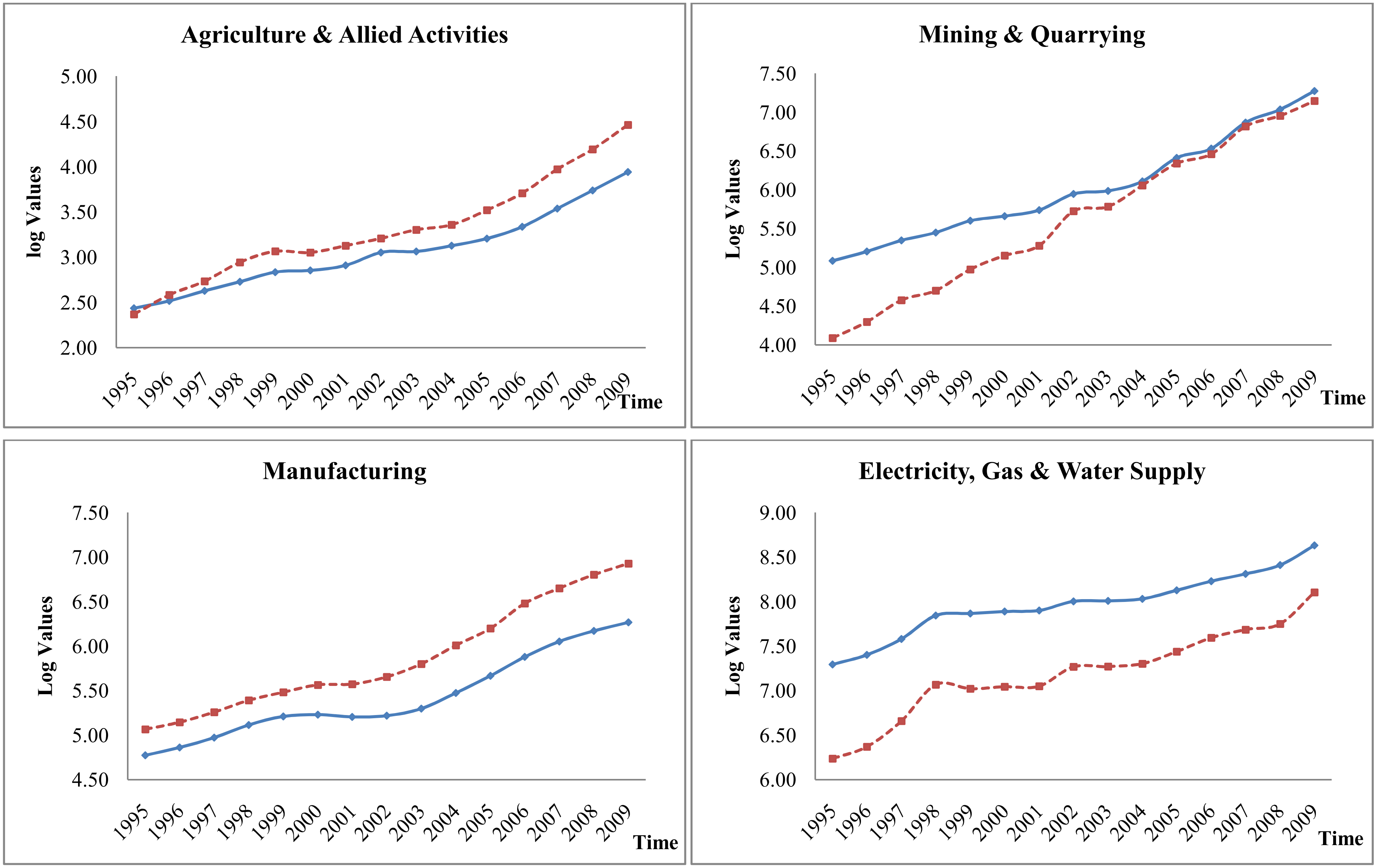
	Productivity growth	Employment growth	Output Growth	Residual
Agriculture and Allied Activities	**15.68**	**0.22**	**15.94**	**0.03**
Mining and Quarrying	**26.38**	**-0.94**	**25.19**	**-0.25**
Food Processing and Beverages	19.49	-1.36	17.86	-0.27
Textile Product	5.34	6.27	11.94	0.33
Leather Product	4.81	6.54	11.67	0.31
Wood Product	5.72	1.39	7.19	0.08
Paper Product	8.72	3.70	12.74	0.32
Rubber, Plastic and Petroleum	32.55	0.69	27.73	-5.51
Chemical product	15.18	-3.64	15.97	4.43
Non-metallic mineral product	12.67	3.06	16.12	0.39
Basic metal and machinery	19.02	0.86	20.05	0.16
Electrical machinery	21.50	0.19	21.73	0.04
Transport equipment	7.25	6.49	14.21	0.47
Recycling and manufacturing nec	11.69	5.60	17.95	0.65
Manufacturing	**14.64**	**2.73**	**17.76**	**0.40**
Electricity, Gas & Water Supply	**11.84**	**0.73**	**12.66**	**0.09**
Construction	**18.44**	**6.34**	**25.95**	**1.17**
Services	**16.55**	**2.85**	**19.87**	**0.47**

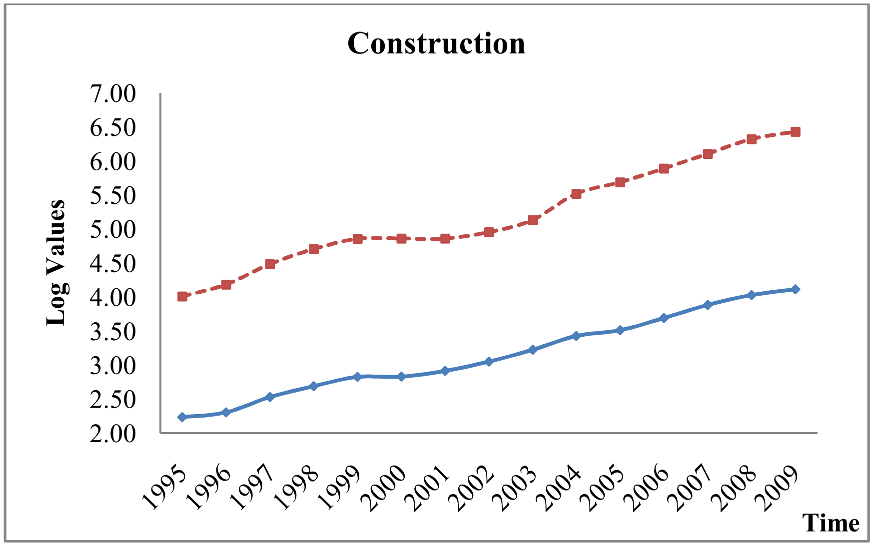
Source: Calculated from data taken from NIOT for India and Socio-economic accounts published by WIOD.

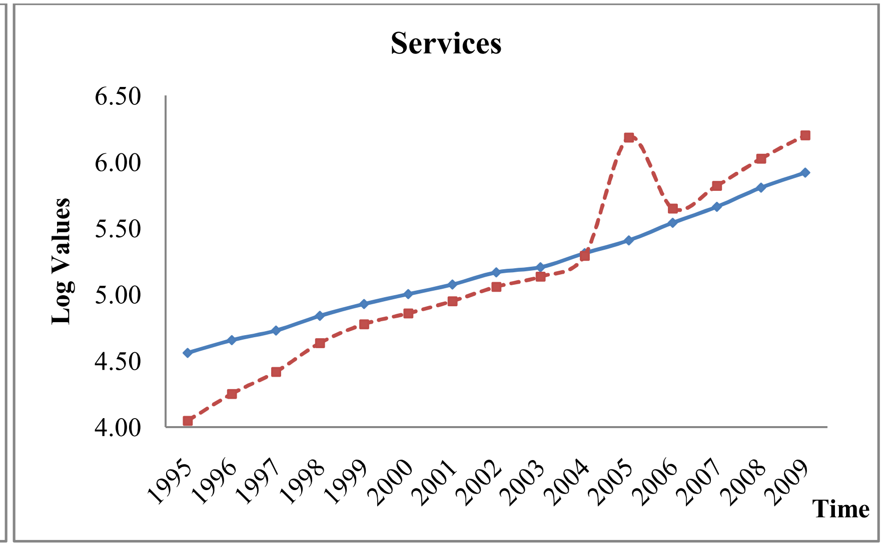
Deflator used: GDP deflator at 2004-05 prices

Note: The figures are Trend growth rates showing the antilogarithms of the relevant regression coefficient minus one when the equations are of the form log Y = a + b T and T refers to time.

Fig. 5.1: Growth of Labour Productivity and Capital Intensity (1995-2009) across Sectors







Source: Source: Calculated from data taken from NIOT for India and Socio-Economic Accounts published by WIOD.

Deflator used: GDP deflator at 2004-05 prices

Note: the red dashed line depicts capital intensity (K/L) and the continuous blue line depicts the Labour productivity (O/L).

Agriculture and allied activities accomplished a productivity growth of 15.6% per annum during the period of study. The output growth was at 15.94%, and the employment growth was 0.22% while 0.03% per annum growth was not captured. Mining and quarrying sector recorded a productivity growth of 26.38% per annum. The output growth was 25.19% for this sector. As there was a negative employment growth in this sector, the productivity growth came out to be higher than the output growth.

The manufacturing productivity grew at 14.64% per annum. The employment growth and output growth recorded in this sector were 2.73%and 17.76% per annum respectively. Among the manufacturing, sectors like Electrical machinery, basic metal product, rubber plastic and petroleum product achieved high growth in productivity. The employment growth in these sectors was, however, very low. Textile sector registered a productivity growth of 5.34% per annum. The productivity growth was slow compared to aggregate manufacturing in mainly labour-intensive sectors like leather product, wood product, paper product, transport equipment and recycling and manufacturing nec. The employment growth in these sectors was also comparatively high.

The productivity growth in the Electricity, gas and water supply was also high, and it increased at 11.84 % per annum. Similarly, for the construction sector, the growth rate of productivity was 18.44 % per annum. The employment growth in both these sector was 0.73 and 6.34 % per annum respectively. The services sector achieved a growth at the rate of 16.55% which could be decomposed into an employment growth of 2.85% and output growth of 19.87% per annum.

5.2.1 Growth in some strategic ratio

Apart from labour productivity, there are some strategic ratios which govern the growth rates. These ratios are capital-labour ratio, capital-output ratio. Kaldor (1957) has given the technological progress function which relates the productivity growth with the growth in capital-labour ratio. To get a deep insight, the trends of capital-labour ratio in different sectors is analysed from the data and is presented in Figure 5.1.

From the figure 5.1, a clear increase in the capital-labour ratio is observable. The capital intensity in the agriculture and allied activities increased from 11.41million rupees per person engaged in 1995 to 51.40 million rupees per person engaged in 2009. In the mining sector, the capital-labour ratio achieved a significant rise. Additionally, the capital-intensity was lower than the labour productivity, but it increased in the study period and converged with the productivity level. The manufacturing sector, on the other hand, is more capital intensive. The capital intensity in this sector increased from 118.18 million rupees per person engaged to 526.91 million rupees per person engaged during 1995 to 2009. The rise in the capital intensity was more for the capital-intensive manufacturing sector. The capital intensity in the electricity gas and water supply was the highest and increased throughout the period. In the services sector, the capital intensity was lower than the labour productivity at the beginning of the period, but it surpassed the labour productivity after the year 2003. On the other hand, although in the construction sector the capital intensity was rising, but the divergence between the productivity was quite high.

Table 5.2 shows the growth rate in the ratios.[3] Agriculture and allied activities had a productivity growth at 13.6% during the study period while the capital intensity growth recorded in this sector was 9.98% per annum. The capital output growth rate in this sector was -3.18% per annum. Similarly the capital intensity growth in Mining sector was16.09% per annum. The Mining and quarrying sector recorded a productivity growth of 24.77% per annum with capital-output ratio increasing at -6.96% per annum.

The manufacturing productivity grew at 14.35% per annum. Capital intensity growth in the manufacturing sector recorded to be 10.81% per annum and capital output ratio grew at -3.10% per annum. Among the manufacturing, sectors like Electrical machinery, basic metal product, rubber plastic and petroleum product recorded high growth in productivity and also the growth rate in capital intensity was very significant. The productivity growth as well as capital intensity growth is slow compared to aggregate manufacturing in sectors like leather product,

[3] The productivity growth rate and employment growth rate figures of table 5.1 and table 5.2 are not matching because of the period taken. In Table 5.1 the period is between 1995 to 2011, but Table 5.2 deals with period 1995 to 2009. The difference in period of analysis is because of the availability of data in socio-economic accounts. Fixed capital stock data is available only up to 2009. So the period taken in the table is 1995 to 2009. For the same reason, Figure 5.1 is also taken for the period 1995 to 2009.

wood product, paper product, transport equipment and recycling and manufacturing nec. The employment growth in these sectors was also comparatively high.

Table 5.2: Growth in Some strategic ratios (1995-2009) (in Percent)

	Capital Intensity Growth	Productivity Growth	Employment Growth	Growth in Capital - Output Ratio
Agriculture and Allied Activities	**9.98**	**13.60**	**0.55**	**-3.18**
Mining and Quarrying	**16.09**	**24.77**	**-0.20**	**-6.96**
Food Processing	13.01	19.23	-1.41	-5.22
Textile Product	5.20	4.24	6.12	0.92
Leather Product and Footwear	6.24	5.32	5.76	0.87
Wood Product	14.33	3.35	1.77	10.62
Paper Product	6.78	8.13	3.80	-1.25
Rubber, Plastic and Petroleum	18.51	33.55	0.76	-7.03
Chemical product	16.93	15.54	-3.83	-3.40
Non-metallic mineral product	9.81	12.39	2.89	-2.30
Basic metal and machinery	14.14	18.10	0.77	-3.36
Electrical machinery	12.52	23.70	-0.85	-9.03
Transport equipment	7.62	4.86	7.62	2.63
Recycling and manufacturing nec	12.72	11.89	4.30	0.74
Manufacturing	**10.81**	**14.35**	**2.47**	**-3.10**
Electricity, Gas & Water Supply	**8.09**	**11.55**	**0.27**	**-3.10**
Construction	**14.46**	**18.18**	**6.54**	**-3.15**
Services	**9.76**	**16.21**	**2.83**	**-5.54**

Source: Calculated from data taken from NIOT for India and Socio-Economic Accounts published by WIOD.

Deflator used: GDP deflator at 2004-05 prices

Note: The figures are Trend growth rates showing the antilogarithms of the relevant regression coefficient minus one when the equations are of the form log Y = a + b T and T refers to time.

The capital intensity growth in the Electricity, gas and water supply was also high, and during the period of study the study period, it increased at 8.09% per annum. On the other hand, for the construction sector, the growth rate of capital-labour ratio was 14.46 % per annum. The capital intensity in services sector grew at a rate of 9.76%. The capital-output ratio in all these sectors was found to be negative.

5.3 Concept of 'system labour productivity'

In the classical framework also the measurement of productivity departed frequently to deal with the interconnected nature of technical change. Leontief (1953) understood the interdependency and recognised the importance of testing the nature of technological change as it might be misleading to look at technical change only as labour-saving.

> It is clear that changes in such a measure do not properly reflect changes amounting to labour used in the economy to produce one unit of final output of industry in question. It is quite conceivable, for example, that over a certain period the industry in question might substitute manufactured inputs for labour in its production process, with the result that it normally measured labour productivity rises rapidly. But when the labour used in the production of these manufactured inputs is taken into account, it might well be found that the total amount of labour used, somewhere in the economy, to produce one unit of final output of the industry in question has fallen only slightly. In other words, the industry measure of labour productivity, in which gross output of an industry is related to industry employment, may move quite differently from the system measure of labour productivity, in which final output of industry is related to total amount of labour used in its production, whether it be used in the industry itself or in the industries supplying inputs to that industry, or in the industries supplying those industries, etc. (Gupta and Steedman, 1971:21)

The above statement not only depicts the nature of independency in the production structure but also its effect on the use of labour. This section will establish the economy as an interdependent system and also measures the changes in the system labour productivity.

5.3.1 Economy as an interdependent system

The self-sustaining underlying interdependencies among various sectors of the economy have become the very foundation of this economic analysis. The economic activity of the whole country is visualised as one huge accounting system. Not only all branches of industry but also the individual budgets of all private persons are included in the system. There after the grand system of general equilibrium by the neo-classical economist was exposed as practically inapplicable and venerable *ceteris paribus*. At this juncture, Leontief's inter-industry model appeared on the scene. The input-output analysis attempted to recognise interwoven net of interdependencies with empirical support. Leontief provided a format for examining the interdependencies structure of an observable and also predicting the change in the structure due to change in the data.

If the economy is divided into n sectors and if we denote X_i the total output of the sector I and by C_i the total final demand for sector i's product, we may write

$$X_i = X_{i1} + X_{i2} + . . . + X_{ii} + . . . + X_{in} + C_i \quad (5)$$

The X terms represent the inter-industry sales by sector I

These elements are the sales to sector I, I's purchases of the products of various producing sectors in the country; the column represents he sources and magnitudes of sector I's inputs. The magnitudes of these inter-industry flows can be recorded in a table with sectors of origin listed on the left and the same sectors, now destinations listed across the top. From the column point of views, these shows each sectors inputs, the rows point of view the figures are each sectors output, hence the name input-output table.

The underlying production function of a Leontief system:

The technical coefficient ratio is the ratio of output of the i^{th} industry needed for the production of one unit of j^{th} industry.

$$a_{ij} = X_{ij}/X_j \quad (6)$$

Input output analysis requires that a sector use inputs in fixed proportions.

Production function relates the amounts of inputs used by a sector to the maximum amount of output that could be produced by that sector with those inputs.

$$X_j = f(X_{1j}, X_{2j}, X_{3j}, . . ., X_{nj};\ L_j) \quad (7)$$

Using the definition of technical coefficient we have,

$$X_j = X_{1j}/a_{1j} = X_{2j}/a_{2j} = . . . = X_{nj}/a_{nj} \quad (8)$$

This is meaningless if a particular input 'I' is not used in the production of j since then a_{ij} = 0 and hence the ratio becomes infinitely large. Thus the more usual specification that is embodied in the input-output model is

$$X_j = min.(X_{1j}/a_{1j}, X_{2j}/a_{2j}, . . ., X_{nj}/a_{nj}) \quad (9)$$

When a_{ij} are not zero, the ratio is the same and when $a_{ij} = 0$, the ratio will be infinitely large and will be overlooked in the process of searching for smallest ratio. This specification of the production function is based on the assumptions like fixed input coefficient in the instantaneous economy and no substitution of the inputs.

The Leontief Matrix:-

The technical coefficient matrix (A) for an 'n' sector economy may be defined as below

$$A = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{pmatrix} \tag{10}$$

So putting the values of X_{ij} into the framework, we get the equations in the general form as follows:-

$$a_{i1}X_1 + a_{i2}X_2 + \ldots + a_{ii}X_i + \ldots + a_{in}X_n + C_i = X_i \tag{11}$$

Representing the 'n' equations in the matrix form

$$\begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{pmatrix} \begin{pmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{pmatrix} + \begin{pmatrix} C_1 \\ C_2 \\ \vdots \\ C_n \end{pmatrix} = \begin{pmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{pmatrix} \tag{12}$$

Rewriting equation (12),

$$AX + C = X$$

Interchanging the sides in above equation,

$$X - AX = C$$

This could be written as,

$$X = (I - A)^{-1}C \tag{13}$$

$(I - A)^{-1}$ is referred to as the Leontief inverse. If the elements in this matrix are denoted by α_{ij} then the general form of the equations will be

$$X_i = \alpha_{i1}C_1 + \alpha_{i2}C_2 + \ldots + \alpha_{ij}C_j + \ldots + \alpha_{in}C_n \tag{14}$$

This equation makes clear the dependence of each of the gross output of a commodity on the values of each final demand of other commodities. The Leontief inverse matrix is instrumental in considering the direct and indirect dependency among the sectors of the economy.

5.3.2 Productivity in an input-output framework

The most common measure of labour productivity in an industry is provided by dividing some measure of output by employment. The changes in such a measure do not properly reflect the changes in the amount of labour used to produce one unit of the final output of the industry in question. Over a certain period, the industry in question may have changed the produced input combination to substitute labour which may lead to a rise in the labour productivity. But the industry labour productivity may move quite differently from the system measure of labour productivity.

The labour coefficient in the input-output matrix gives the direct labour in use. It gives the ratio of labour required to produce a unit of output for that sector.

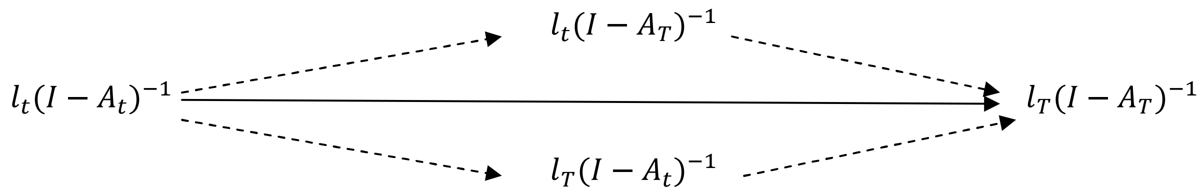
$$l_{ij} = \frac{L_{ij}}{X_j} \qquad (15)$$

The increment in output in a certain sector not only affects the employment of that sector but also it has indirect effect on the employment of other sectors. So there will be a cumulative increment in the employment. The system labour coefficient for an industry measures the total labour required to produce a unit of output for the sector.

$$l_{ij}^{S} = l_{ij}(I - A)^{-1} \qquad (16)$$

If both labour coefficient and input coefficient matrix change between two different time periods, the change in total labour use is the compound effect of the changes in the industry labour productivity and changes in inter-industry use of intermediate goods. So two cases arise which is described below in the form of a chart[4]:

[4]Gupta & Steedman (1971: 22).



In an open economy, the system labour coefficient:

$$l_{ij}^S = l_{ij}[I - (A + M)]^{-1} \quad (17)$$

The incorporation of imported inputs in system labour productivity improves the implications of the measure. As in case of India (see Section 7.3 and Fig. 7.3), the use of imported and advanced inputs may help Indian industries to acquire high productivity. Equation (17) implicitly takes care of these biases due to openness of the economy.

The use of system labour productivity is very useful in the policy implications. To implement policies on employment generation, it would be wrong to use direct labour use as a measure. There are particular industries where the ranking of the industry according to direct labour use and total labour use may vary significantly in the economy. The system measure will serve better to decide on the sectors which are more labour saving and which are more labour using. So the system measure facilitates ranking of industries according to their labour intensity. The measure will be helpful in the policies that aim at transfer of labour from one sector to other.

5.4 Estimation of 'system labour productivity' and analysis

5.4.1 Findings from the trends of industry and system labour productivity

From the labour coefficient, it can be seen that for each of the sectors the coefficient has declined. So it is obvious that the labour productivity has increased in the sectors during the period of study. The industry productivity for each sector has increased so also the system labour productivity. The value of industry productivity is higher than the two specific indices of system labour productivity. Further the system labour productivity with import coefficient is higher than the system labour productivity without import coefficient. A close look at the system labour productivity index shows for Agriculture & allied activities both the indices though similar they diverge through the period. The system labour productivity for Agriculture & allied activities has increased throughout the period. In 1995, the system labour productivity (without import coefficient) was 8.95 million per thousand labour which increased to 129.7 in the year 2011. For the same sector the system labour productivity with import coefficient increased from 9.02 million per thousand labour in the year 1995 to 130.7 million per thousand labour in 2011. The trend of the system labour productivity indices entailed a negligible impact of trade on agricultural productivity. System labour productivity in the mining sector was less than the industry labour productivity. The divergence between the system labour productivity and industry labour productivity for the sector grew over the period. The system labour productivity indices of the sector had also increased divergences. System labour productivity with import coefficient increased from 38.19 million per thousand persons in the year 1995 to 1538.09 million per thousand labour in the year 2011. The sectoral linkages of the manufacturing sector are very strong with the rest of the world. The industry labour productivity was 158.12 million per thousand labour in 1995 and the system labour indices without and with import coefficient in 1995 were 27.49 million per thousand labour and 31.11 million per thousand labour. The productivity increased in this sector throughout the period. The system labour productivity of all the manufacturing sectors increased in the period of study. The trend of increase in the sectors like Textile, Leather, Wood product, Paper product, non-metallic mineral product and recycling & manufacturing nec had been similar as in these sectors the system labour productivity had increased from a period of decline. A U-shaped trend of change could be well discerned in a portion. The sectors with u-shape kind of trend are mainly labour-intensive sectors. In other manufacturing sectors, the system labour productivity had grown steadily. The divergence between both the system labour productivity indices is more in these sectors as compared to others. Electricity, gas & water supply, as well as construction sectors, recorded system labour productivity. The divergence of industry labour productivity and system labour productivity had also increased during the period of study. The system labour productivity of the services sector too recorded growth during the period of study. The system labour productivity without import coefficient increased from 35.97 million per thousand labour to 465.90 million per thousand labour. The index with import coefficient increased from 38.22 million per thousand labour to 508.6 million per thousand labour. (See Table A5.1 in Appendix of the chapter)

Table 5.3 Growth Rate of Different measures of Labour Productivity (1995-2011) (in Percent)

	Industry Productivity	System Productivity (without import coefficient)	System Productivity (with Import coefficient)
Agriculture & allied activities	**15.68**	**15.95**	**15.96**
Mining and Quarrying	**26.38**	**24.11**	**23.79**
Food processing	19.49	14.82	14.71
Textiles Product	5.34	9.15	8.94
Leather Product and Footwear	4.81	6.18	6.49
Wood and Product	5.72	8.98	8.90
Paper product	8.72	9.96	10.13
Rubber, Plastic & Petroleum Product	32.55	20.32	20.62
Chemicals Product	15.18	15.01	14.46
Non-Metallic Mineral product	12.67	12.78	13.05
Basic metal products	19.02	17.17	16.54
Electrical machinery	21.50	13.50	12.63
Transport Equipment	7.25	11.93	11.23
Recycling & Manufacturing Nec	11.69	15.29	11.53
Electricity, Gas and Water Supply	**11.84**	**12.57**	**11.39**
Construction	**18.44**	**17.84**	**17.62**
Services	**16.55**	**16.57**	**16.30**

Source: Calculated from Input-Output Transaction table published by WIOD

Deflator Used: GDP Deflator

Base Year: 2004-05 prices

Note: The figures are Trend Growth rates showing the antilogarithms of the relevant regression coefficient minus one when the equations are Log Y = a+ bT and T refers to Time.

Table 5.3 gives a comparative presentation of growth rate of different labour productivity measures. The growth rate of Industry labour productivity is explained in section 5.2. During the period 1995 to 2011, the system labour productivity (without import coefficient) grew at 15.95% for the agriculture and allied activities and the same sector the system labour productivity with import coefficient was 15.96%. For agriculture and allied sector the system labour productivity measures grew faster than the industry labour productivity. The system labour productivity (without and with import coefficient) growth was 24.11% and 23.79% respectively. These growth rates are lower than the industry productivity growth for this sector. Among the manufacturing industry groups, the growth rate of system labour productivity without import coefficient was higher than the growth of the measure with import coefficient, were food product, chemical product, basic metal product, electrical and optical equipment, transport equipment and manufacturing nec., and recycling. The industry productivity growth was than the growth in the measures of system labour productivity were food processing, rubber plastic and petroleum product, chemical product, non-metallic mineral product, basic metal product and electrical and optical product (For details see Table 5.3). For electricity gas and water supply, construction and services the system labour productivity without import coefficient was higher than the system labour productivity with import coefficient.

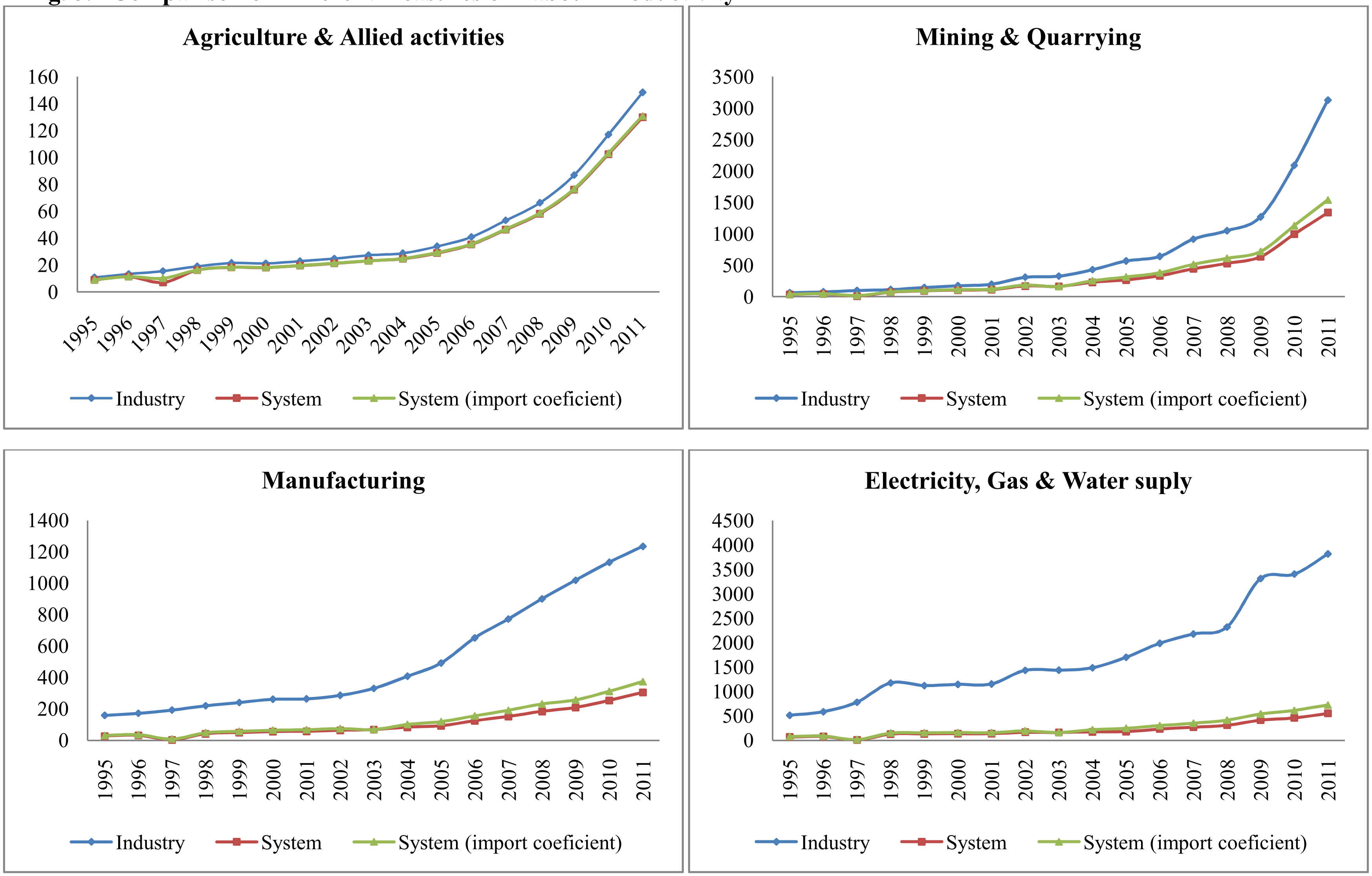
There is a strong tendency for the element of the direct labour use vector to fall and from the calculation, it is found that the system labour use have declined. The industry productivity growth was less than the system productivity growth for the sectors like agriculture & allied activities, textile manufacturing, leather & leather products, wood products, paper products, other non-metallic mineral products, and transport equipment. The industry productivity in these sectors is very high in comparison to the system labour productivity in 1995. Another important trend in the different measures of productivity for these sectors was that after the year 2004, the industry productivity grew very fast in comparison to system labour productivity as observed from the increasing divergence between the measures. For the other sectors where the growth of industry labour productivity was greater than the system labour productivity indicated a rise in the adoption of more roundabout methods of production i.e. increasing use of indirect labour.

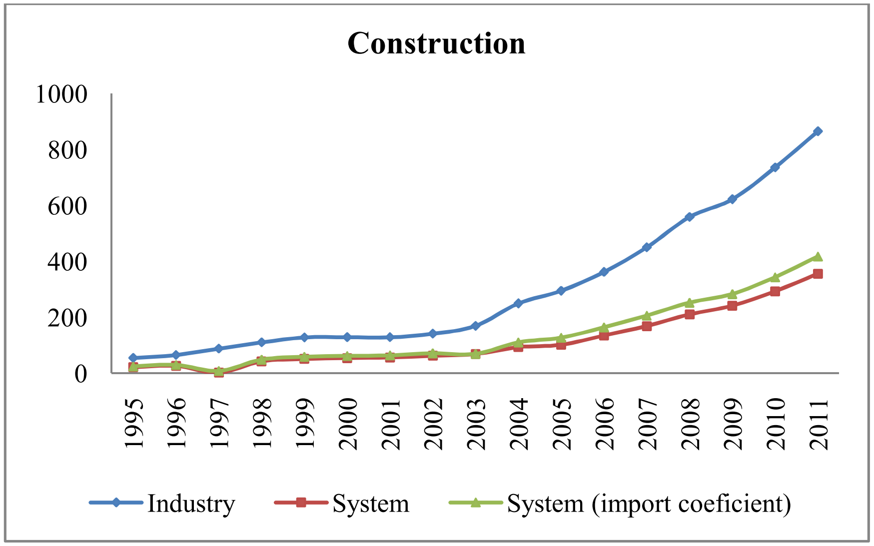
5.4.2 The mixed total labour vectors and the nature of technical change-

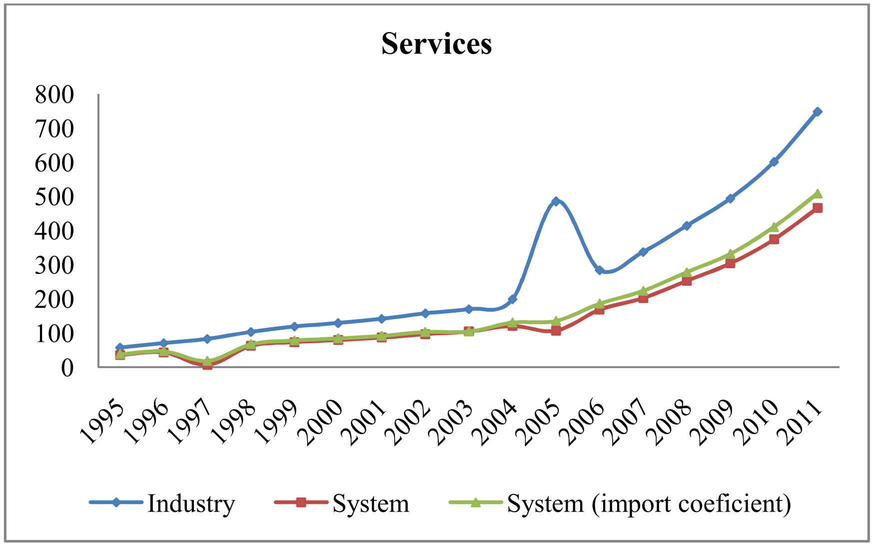
The system labour productivity is increasing slowly in comparison to the industry labour productivity for all the sectors. This confirms a fall in the direct labour use. But it does not show any tendency of the total (both direct and indirect) labour use. If there is a strong tendency to fall in the input-output matrix, then we would expect that for two different time period t & T where t<T,

$$l_t[I-(A_t+M_t)]^{-1} > l_t[I-(A_T+M_T)]^{-1} > l_T[I-(A_T+M_T)]^{-1} \qquad (18)$$

Fig. 5.2 Comparison of Different measures of Labour Productivity







Source: Calculated from Input-Output Transaction table published by WIOD

Deflator Used: GDP Deflator

Base Year: 2004-05 prices

The mixed total labour use vector would lie between the initial and final actual total labour use vectors. The above condition would refer to fall in use of produced inputs but not the fall in use of direct labour.

In Table 5.4, mixed labour vector for four different time intervals are presented. The first row in each section of the table, gives the total labour requirement vector in the starting point of the period; the second row gives the mixed vector which is the matrix multiplication of labour coefficient vector in the starting point and the Leontief inverse of the end period; the third row gives the total labour requirement vector in the end period.

Case 1: for time between 1995 to 1999:-

It is clear that the total labour use had declined in these years. But the mixed labour vector shows

$l_{95}[I-(A_{99}+M_{99})]^{-1} > l_{95}[I-(A_{95}+M_{95})]^{-1}$is true for Textile, Leather, Paper, other non-metallic mineral product, Ferrous & basic metal products, electrical machinery, transport equipment and electricity, gas & water supply sector. So for these industries over the period 1995 to 99, a falling tendency in the direct labour input vector was combined with a rising tendency in the use of produced input to result in a fall in total labour use and increase in system labour productivity.

Case 2: for time between 1999-2004:-

The mixed labour vector $l_{99}[I-(A_{04}+M_{04})]^{-1} > l_{99}[I-(A_{99}+M_{99})]^{-1}$ is satisfied by sectors like leather product, paper product, other non-metallic products, electrical machinery, transport product and recycling & manufacturing nec., and electricity. In case of the wood product during the period, both the l_{99} and the use of produced inputs had declined.

Case 3: for time 2004-2011:-

$l_{04}[I-(A_{11}+M_{11})]^{-1} > l_{04}[I-(A_{04}+M_{04})]^{-1}$

In this period the mixed total labour vector had increased in all sector except for agriculture and mining sector. So between the period 2004 to 2011, the system labour productivity increased in all sectors except Agriculture and allied activities due to the combined effect of falling direct labour use and produced input use. For Agriculture and allied activities, the system productivity grew because of fall in the use of produced inputs.

Case 4: for time between 1995-2011:-

$$l_{95}[I-(A_{11}+M_{11})]^{-1} > l_{95}[I-(A_{95}+M_{95})]^{-1}$$

This condition holds true for the sectors like Food products, Textile product, leather product, wood product, other non-metallic mineral product, metal products, electrical machinery, transport equipment, recycling & manufacturing nec., electricity and services. The rising use of produced input and fall in direct labour use in these sectors caused a fall in the total labour use. But fall in the produced inputs in Agriculture and allied activities, Mining, Rubber, plastic and petroleum and Construction sectors caused system productivity to grow.

Table 5.4 Mixed Labour Vectors:

1995 to 1999									
Sectors	A+B	C	15+16	17+18	19	20	21+22	23+25	24
$L_t\ (1-A_t)^{-1}$	0.111	0.026	0.077	0.036	0.028	0.058	0.024	0.033	0.025
$L_t\ (1-A_T)^{-1}$	0.110	0.023	0.072	0.041	0.030	0.047	0.026	0.031	0.024
$L_T(1-A_T)^{-1}$	0.055	0.010	0.037	0.022	0.014	0.027	0.016	0.016	0.012

Sectors	26	27+28+29	30+33	34+35	36+37	E	F	G
$L_t\ (1-A_t)^{-1}$	0.024	0.02	0.014	0.016	0.027	0.013	0.042	0.026
$L_t\ (1-A_T)^{-1}$	0.026	0.021	0.019	0.016	0.027	0.013	0.037	0.026
$L_T(1-A_T)^{-1}$	0.015	0.012	0.01	0.009	0.016	0.007	0.018	0.013

1999 to 2004									
Sectors	A+B	C	15+16	17+18	19	20	21+22	23+25	24
$L_t\ (1-A_t)^{-1}$	0.055	0.010	0.037	0.022	0.014	0.027	0.016	0.016	0.012
$L_t\ (1-A_T)^{-1}$	0.055	0.010	0.036	0.020	0.019	0.032	0.016	0.011	0.011
$L_T\ (1-A_T)^{-1}$	0.040	0.004	0.024	0.017	0.015	0.037	0.011	0.005	0.007

Sectors	26	27+28+29	30+33	34+35	36+37	E	F	G
$L_t\ (1-A_t)^{-1}$	0.015	0.012	0.010	0.009	0.016	0.007	0.018	0.013
$L_t\ (1-A_T)^{-1}$	0.016	0.011	0.011	0.009	0.017	0.008	0.016	0.013
$L_T\ (1-A_T)^{-1}$	0.011	0.006	0.006	0.006	0.011	0.004	0.009	0.008

2004 to 2011									
Sectors	A+B	C	15+16	17+18	19	20	21+22	23+25	24
$L_t (1-A_t)^{-1}$	0.040	0.004	0.024	0.017	0.015	0.037	0.011	0.005	0.007
$L_t (1-A_T)^{-1}$	0.039	0.004	0.028	0.019	0.020	0.038	0.013	0.006	0.008
$L_T (1-A_T)^{-1}$	0.008	0.001	0.006	0.007	0.006	0.008	0.004	0.001	0.002
Sectors	26	27+28+29	30+33	34+35	36+37	E	F	G	
$L_t (1-A_t)^{-1}$	0.011	0.006	0.006	0.006	0.011	0.004	0.009	0.008	
$L_t (1-A_T)^{-1}$	0.011	0.006	0.007	0.007	0.013	0.005	0.009	0.008	
$L_T (1-A_T)^{-1}$	0.003	0.002	0.002	0.002	0.004	0.002	0.003	0.002	

1995 to 2011									
Sectors	A+B	C	15+16	17+18	19	20	21+22	23+25	24
$L_t (1-A_t)^{-1}$	0.111	0.026	0.077	0.036	0.028	0.058	0.024	0.033	0.025
$L_t (1-A_T)^{-1}$	0.106	0.021	0.081	0.044	0.053	0.059	0.031	0.023	0.025
$L_T(1-A_T)^{-1}$	0.008	0.001	0.006	0.007	0.006	0.008	0.004	0.001	0.002
Sectors	26	27+28+29	30+33	34+35	36+37	E	F	G	
$L_t (1-A_t)^{-1}$	0.024	0.02	0.014	0.016	0.027	0.013	0.042	0.026	
$L_t (1-A_T)^{-1}$	0.028	0.021	0.024	0.021	0.033	0.019	0.035	0.027	
$L_T (1-A_T)^{-1}$	0.003	0.002	0.002	0.002	0.004	0.002	0.003	0.002	

Source: Calculated from Input-Output Transaction table published by WIOD

Deflator Used: GDP Deflator

Base Year: 2004-05 prices

5.4.3 Law of decreasing labour content

The law of decreasing labour content theorises a basic feature of capitalist development. It refers to the fall in the use of labour over the period for producing a commodity. "If C is a commodity produced in a capitalist economy over a certain period, then there is virtual certainty that the labour content of one unit of C will be lower at the end of the period than it was at the beginning."[5] Farjourn and Machover treat this law as equivalent to law of increasing labour productivity. They also believe "Without the concept of labour content, economic theory would be condemned to scratching the surface of phenomena and would be unable to consider, let alone explain, certain basic tendencies of the capitalist mode of production. (1983, 97)" Moreover, the

[5] Farjourn and Machover (1983): Laws of Chaos, 97.

law focus on labour content of goods rather than the sectors which mean the law incorporates the interdependencies between sectors and therefore it allows capturing the change in production technology.

The system productivity measure defined in the chapter gives a measure of declining labour content. From fig. 5.2, it is clearly seen that the labour productivity increased during the period of study. The mixed technology analysis in section 5.4.2 shows for commodities from mostly labour intensive sectors the use of direct labour has declined. This shows a declining labour content in case of labour intensive commodity during the period.

5.5 Employment potential of sectors

Over the past few decades, there is a marked decline in the employment growth in response to an output growth in many countries across the globe (ILO 2013; Caballero and Hammour 1997; Basu and Das 2016). India is not an exception to the trends as the labour-absorbing capacity has declined (Papola, 2006; Kannan and Raveendran 2009). For a labour surplus country like India, it becomes a key challenge for a sustained economic growth. The aggregate employment elasticity may not give any indication to the complexity of the problem, so sectoral level employment elasticity is analysed to get employment perspective.[6] Like In this chapter, the role of sectoral potential in generating direct and indirect labour, those are known to influence system productivity, will be analysed. This may point out at the strategic sectors with ample possibility of employment generation.

In Table 5.5, the elasticity of employment is presented for the period from 1995 to 2011. The overall organised elasticity of employment was 0.23 which was very low in comparison to 3.97 in case of total employment elasticity. The proportionate change in employment due to change in NDP is very low in India. Individual sectors registered different elasticity of employment. The service sector employment elasticity (2.855) was the highest among the sectors, but for the organised service sector, the measure of elasticity was very low (0.065). The organised manufacturing sector suffered from low employment elasticity, but overall

[6] See for details, Papola and Sahu (2012).

manufacturing sector was relatively elastic (1.982). Agriculture & allied activities with the highest share in the country employment suffered from low employment elasticity.

Table 5.5: Employment Elasticity (1995-2011)							
	Agr.	Min.	Manf.	Elect.	Const.	Serv.	Overall
Organised (NDP in Crore, Employment in Lakh)	-0.070	0.092	-0.036	-0.236	-0.213	0.065	0.023
Total (NDP in Crore, Employment in Lakh)	0.817	-0.582	1.982	1.865	1.334	2.855	3.977

Source: For organised sectors, NDP data collected from NAS and employment data from DGE & T; For Overall sectors, NDP data collected from NAS and employment data from Socio-economic accounts, WIOD.

Deflator: GDP deflator at 2004-05 prices

Note: Calculated using Double-log regression. $\log(employment) = \alpha + \beta \log(NDP)$. Here β coefficient will give the measure of elasticity.

The direct and indirect employment potential of the sectors can be estimated through the input-output table. The corresponding changes in the employment potential of the sectors can be traced through the analysis. Hazari and Krishnamurthy (1970) have carried out similar analysis to get employment implication of the industrialisation using the input-output table for the year 1964-65 published by the perspective planning division. This analysis is a development over their analysis as it takes into account a period and traces the changes in the employment potential of the sectors.

The following model is being used:[7]

$$\begin{pmatrix} l_1 & 0 & \cdots & 0 \\ 0 & l_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & l_n \end{pmatrix} \begin{pmatrix} \alpha_{11} & \alpha_{12} & \cdots & \alpha_{1n} \\ \alpha_{21} & \alpha_{22} & \cdots & \alpha_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \alpha_{n1} & \alpha_{n2} & \cdots & \alpha_{nn} \end{pmatrix} \begin{pmatrix} F_1 & 0 & \cdots & 0 \\ 0 & F_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & F_n \end{pmatrix} = \begin{pmatrix} l_1\alpha_{11}F_1 & l_1\alpha_{12}F_2 & \cdots & l_1\alpha_{1n}F_n \\ l_2\alpha_{21}F_1 & l_2\alpha_{22}F_2 & \cdots & l_2\alpha_{2n}F_n \\ \vdots & \vdots & \ddots & \vdots \\ l_n\alpha_{n1}F_1 & l_n\alpha_{n2}F_2 & \cdots & l_n\alpha_{nn}F_n \end{pmatrix}$$

where α_{ij} is the elements of the Leontief inverse; $l_i$is direct labour coefficient; F_j is the final demand of the j^{th}sector and w_i is sectoral wage rates.

[7]Hazari & Krishnamurthy (1970: 181).

The vector $[l_1\alpha_{11}F_1, \quad l_2\alpha_{21}F_1 \quad \ldots \quad l_n\alpha_{n1}F_1]$ gives the direct and indirect labour cost to sustain the level of final demand F_1. The number of workers employed directly or indirectly would be $\sum_{i=0}^{n}(\frac{l_i\alpha_{ij}F_j}{w_i})$ where j = 1 to n.

To make inter-sectoral comparisons of the effect of final demand on the direct and indirect employment created, the following ratios are used:

$$\frac{\sum_{i=j}\alpha_{ij}}{\sum_{i=1}^{n}\alpha_{ij}} = \frac{direct\ output}{total\ output}$$

$$\frac{\sum_{i=j}l_i\alpha_{ij}}{\sum_{i=1}^{n}l_i\alpha_{ij}} = \frac{direct\ wage\ cost}{total\ wage\ cost}$$

$$\frac{\sum_{i=j}(\frac{l_i\alpha_{ij}}{w_i})}{\sum_{i=1}^{n}(\frac{l_i\alpha_{ij}}{w_i})} = \frac{number\ of\ workers\ employed\ directly}{total\ workers\ employed}$$

$$\frac{\sum_{i=1}^{n}(\frac{l_i\alpha_{ij}F_j}{w_i})}{F_j} = numberofworkers\ employed\ per\ unit\ of\ final\ demand$$

The direct and indirect output and employment effects of the sectors can be determined by using the ratios given above. The results are presented as a form of bivariate table in the appendix of the chapter (Table A5.3). The sectors are placed in the cells in the ranges of percentage share of direct output in total output and direct employment in the total employment.

Agriculture & allied activities was the only sector in the range 80-90% in the output and 90-100% in employment. The forward linkage of this sector was very strong. Agriculture had been a basic input provider for the agro-based industries, but the backward linkage was weak. This sector also created substantial employment per unit of final demand. The sector ranked one for its employment potential, but the potential declined substantially and steadily during the period of study. Hazari& Krishnamurthy (1970) have objected to a policy on the basis of technological linkages which don't exploit the employment potential of the sector.

Mining sector during the study period can be located in a group of 60-70 of direct output and 30-40% or 20-30% of the direct employment group. The backward linkage of the sector was low whereas that of the forward linkage was strong. The employment generating capacity of the sector had been poor as it ranked 16 in this category among 17 sectors up to 2001, and after that it ranked 17th. The direct employment generation potential was also very low. So investment in this sector should be made on the basis of technological linkages.

The sectors which come broadly under manufacturing fall in the categories of 60-70%, 50-60%, 40-50% and 30-40% of direct output group. Basic metal product only comes in the 60-70% direct output interval. The sectors like Non-metallic mineral product, wood product, chemical, textile, paper product, food processing, transport equipment and electrical machinery fall under the direct output proportion interval of 50-60% and 40-50%. Recycling & Manufacturing nec., and rubber plastic & petroleum product start at the lower proportion range of 30-40% but later on they shifted to the range of 40-50% of direct output proportion.

The direct employment range of the sectors within the manufacturing appeared in the lower end i.e. less than 40%. Much of the sectors emerged in the 0-10% and 10-20% range. Leather, chemical, transport equipment, electrical machinery sectors appeared in the lowest range of 0-10% for the most of the period. Other than these manufacturing sectors, rubber plastic & petroleum product, food processing and basic metal products emerged in the lowest range of direct employment proportion while wood product, non-metallic mineral product and recycling & manufacturing nec., appeared in the high range of direct employment proportion. They come under the 60-50%, 50-40% and 30-40% of direct employment. Textile sector earlier in the study period appeared under the lower range of employment but later it improved its direct employment proportion. The other two sectors namely paper product and Basic metal product appeared in the low employment range. But the proportion increases for both these sectors, and in the later period, they appeared in the 20-30% range of direct employment proportion.

The backward linkage as far as the linkage indices are concerned, was strong for the sectors like food processing, textile, leather, paper product, rubber plastic & petroleum product, chemical, basic metal product, electrical machinery, transport equipment. For other manufacturing sectors like wood product and non-metallic mineral product the indexes were within intermediate range. The forward linkage was, however, high for chemical product and basic metal product only. Textile, paper products demonstrated intermediate forward linkage.

The linkage for rubber plastic & petroleum product and recycling & manufacturing nec., increased and had become strong in the later half of the study period.

The employment potential of the manufacturing sector was high for food processing, wood product, textile, leather, rubber plastic product, non-metallic mineral product. Transport equipment, electrical machinery, basic metal product, on the other hand, had very low employment potential.

Food processing, wood product, textile sectors are mainly labour intensive sector. Among other labour-intensive sectors are leather product, paper product and recycling & manufacturing nec. Chemical sector is found to be a key sector as it has strong forward and backward linkages. Many of the labour intensive sectors are agro-based and have high employment potential. To enhance the employment generation capacity of these sectors, investment policy should be planned, taking the technological linkage and output capacity into account. However, the employment generating process may not be overlooked. There is high potentiality among the manufacturing sectors to create indirect labour, and that has to be exploited. So manufacturing sectors have to be the main sector of promoting employment generation.

Construction sector largely for the concerned study period emerged in the 40-50% output range and 20-30% of direct employment range. The backward linkage of construction sector was strong where as the forward linkage was weak. According to employment potential, construction sector remained in the middle in the sectoral distribution. Electricity, gas & water supply sector had very low employment potential. The sector had a high output range of 60-70%, but the direct employment range was only 0-10%. This sector had an intermediate backward linkage and a strong forward linkage suggesting that the investment policy on the basis of technology in production process would be helpful for the growth of this sector.

Services sector appeared mostly in the 70-80% of direct output proportion range and 40-50% of direct employment proportion range. The employment potential of services was also low as it ranked at the lower end. This sector had high forward linkage where as the backward linkage was weak. This sector exhibited high direct employment proportion, but due to capital-intensive production process, the employment potential of the sector was not up to mark. So the investment policy should aim at promoting technology which uses direct employment.

5.6 Conclusion

From the above analysis, it is clear that the labour productivity of the sectors may have grown up, but it could give a wrong impression on how much it grew. Due to the inter-sectoral linkages, the productivity growth of some other sectors may be reflected in the productivity growth of a different sector. So the system labour productivity entails the productivity growth in a more precise manner. The index is also helpful in determining the technology of production process. The mixed labour vector analysis shows whether the changes in input uses or changes in labour coefficient determine the productivity change. The rise of use of produced inputs in the food processing, textile, leather, wood product, non-metallic mineral products, caused fall in the use of direct labour use. In most of the labour intensive sectors like agriculture & allied activities, textile product, leather product, wood product, paper product, non-metallic mineral product, manufacturing nec., and recycling, the labour productivity grew because of change in the input use but not due to change in labour coefficient. Also, the analysis is helpful in tracing the important sectors having more employment potential. These sectors also have greater employment potential. So the investment policies on these sectors on the basis of production technology may hamper the employment generation.

Conclusions and Policy Implications

Productivity as a source of growth has long been recognised and has invited intense debate in the literature in the study of developing countries. The study has taken the productivity of labour as the sole source of dynamism in the economy. The structure of the thesis is designed to understand the theoretical as well as the empirical shortcomings of the conventional approaches measuring productivity. At the same time, alternative approaches to productivity measurement from the classical economics are pursued. The use of input-output transaction table is not only helpful as a tool to measure productivity but also has its implications in measuring intersectoral linkages, technological progress, and also employment generation.

6.1 Major findings from the study

The conventional studies on productivity are based on the neoclassical theory of distribution. Most of the studies concluded that much of the source of growth in output remained unanswered by growth in inputs. The realised gap between output growth and input growth was conceptualised differently by different economists. The neoclassical theory that backs these empirical studies is based on much-debated assumptions like constant returns to scale, perfect competition, continuous Solow-type production function, smooth substitution between factor inputs.

The important debate on productivity the measurement in neoclassical literature has been correctness in measuring factor inputs. Kaldor, Robinson, Fisher, Abramovitz are few to name who talked about the impossibility of building an aggregate index for capital because it is heterogeneous in nature. There is an intense debate on the measurement of capital input between Jorgensen & Griliches versus Denison (Jorgensen & Grilliches, 1966; Denison, 1964, 1966). They also debated on the question of embodiment of technical progress in the new machinery. The neoclassical theory of productivity and growth is criticised for not being supported by empirical evidence (Nelson, 1981; Fabricant, 1954; Shmookler, 1952).

Another debate was on the measurement of real value added. Most of the empirical studies resorted to real value added by single deflation method. The double-deflation method is considered as an appropriate method but its lacking in application is justified on the ground of data limitation. Again, the additive assumption and requirement of a fixed base also hinder the applicability of double deflation method. Another point in this regard is that the method does not look at the economy as an interlinked system.

The second and third chapter deals with the estimation of TFP through growth accounting method and the production function approach respectively. The estimation is carried for all the sectors by using both single-deflation and double-deflation method over the period 1995-2009. The double deflation method results in a slow or negative growth in TFP in contrast to the high growth by single deflation method. The labour-intensive sectors like agriculture and allied activities, textile products, leather products, wood products, paper products have very slow TFP growth. The estimation of C-D production function shows presence of TFP growth in the services, construction and mining. In manufacturing, the labour intensive sectors demonstrate a negative TFP growth. The CES production function gives idea about some critical policy parameters. The elasticity of substitution parameter is found to be greater than one in case of paper product, chemical product and transport equipment whereas it is less than unity for other sectors. So the estimation of Cobb-Douglas production function is itself inappropriate due to misspecification bias for these sectors. The estimation of Translog production function shows TFP growth only in the construction sector when calculated through single deflation method. The growth rate of TFP is found to be positive in agriculture and allied activities, mining and quarrying and manufacturing by the double-deflation method. The estimates do not conclude decisively about TFP growth in the case of registered manufacturing sector. The Cobb-Douglas and CES production function estimates show positive TFP growth while Translog Production function estimates show negative TFP growth both by single as well as double deflation method.

Growth accounting is undertaken without ascertaining the form of the production function underlying the data. The default method is to work with a Cobb-Douglas production function with Hicks-neutral technical progress. The Solow index is based on the Cobb-Douglas production function with constant returns to scale and with Hicks neutrality. But it does not satisfy any of the assumptions in empirical estimation. So the Solow index calculated by following the C-D production function does not give any consistent results. From the calculation, it can be seen that the share of labour and capital in GVA is changing over the period of time. The share of labour has a declining tendency and the opposite is for the share of capital. Had these shares remained constant for the time period, it would have given correct estimate of technical progress.

Growth accounting measures do not recognise the growth of human capital, economies of scale, organisational improvement. A faster capital accumulation means a faster incorporation of advance of knowledge. Investment decisions of the firms are guided by expected profit. So the changing profitability of production is a better guide for growth, planning and policy making. TFP growth could not help in this regard. The process of embodiment is clearly ignored. There is no division in the labour compensation according to the quality of labour i.e., no separate labour index composite of educational attainment. In many studies on productivity growth, this aspect has been neglected. It implies that they have taken technical progress as exogenous. Many studies evidenced that there is an increase in TFP in the post-reforms period. But no conclusions can be made whether the growth is due to trade liberalisation or some other factors. The methods can't take the conscious notes on the impact of trade liberalisation on technical progress.

The analysis in fourth chapter demonstrates that the labour productivity growth for different sectors is high during the study period. For the organised sector, the labour productivity has increased much faster than the unorganised sector. The ratio of labour productivity of organised to unorganised sector gives a clear indication of rapid growth in productivity in organised sector during the period, 1983-84 to 2011-12.

The sectoral productivity growth is the highest in the case of service sector during 1983-84 to 2011-12. In the post liberalisation period, it grew at rate of 5.82% per annum. The growth in manufacturing is also significant. The productivity of manufacturing was high in the post liberalisation period and particularly in the second half of liberalisation policy. The agricultural growth was very low during the entire study period 1983-84 to 2011-12. The growth in the labour productivity of organised sector was higher than that of the unorganised sector. But the unorganised components of sectors like agriculture and allied activities, mining and quarrying, and electricity, water and gas supply sector grew at a higher rate than their counterparts in organised sectors.

In the analysis of organised manufacturing using the ASI data, it is found that the growth and trend of labour productivity in the post liberalisation period has been increasing.

The roundabout methods of production and high degree of demand for these products have been the driving force behind the productivity growth. The increasing returns to scale, the use of roundabout production process, and introduction of new machinery, demand dependency, privatisation and inflow of investments have been the main causes affecting productivity growth. The operation of the increasing returns to scale in the factor employment has played a significance role in determining the size of productivity. The elite industries employing larger labour or larger capital have enjoyed an upper hand in the productivity rise. These elite industries have a larger contribution in productivity increase as compared to their smaller counterparts. In the post-liberalisation era, the corporate enterprises have grown at a rapid pace which hints at the operation of scale economies.

In India's merchandise trade, manufacturing has been the dominant sector. It constitutes around 70% of the total export as well as 78.6% of imports in 2011. Another major concern in India's import has been an increasing share of imported material in the total material consumed as they may overstate the domestic productivity growth. The increased use of capital-intensive technology and also increased use of imported materials in the production has negative effect on the employment growth. Much of the employment growth depends on the increase in the domestic demand and export increase. If these two factors rise in the labour-intensive sectors then it would help in generating more employment. Also in the era of globalisation, the trade composition has to be taken care of very carefully to generate ample employment. The external sector has a very prominent role to play in employment generation. India lags behind the other contemporary economies in exploiting the comparative advantage in the unskilled labour intensive sector. The low vertical specialisation of the economy obstructs the trade specialisation process.

The fifth chapter gives an alternative to the direct (Industry) labour productivity. The analysis shows that the labour productivity of the sectors may have grown up but it could give a wrong impression on how much it has actually grown. Due to the intersectoral linkages, the productivity growth of some other sectors may be reflected in the productivity growth of a different sector. So, the system labour productivity entails the productivity growth in a more precise manner. From the labour coefficient, we found that for all of the sectors, the coefficient has declined. So it is obvious that the labour productivity has increased in these sectors during the period of study. The industry productivity for each sector has increased so also the system labour productivity. The value of industry productivity is higher than the two specific indices of system labour productivity. Further the system labour productivity with import coefficient is higher than the system labour productivity without import coefficient.

A close look at the system labour productivity index shows that for agriculture and allied activities both the indices though similar but they diverge over the period. The system labour productivity for agriculture & allied activities has increased throughout the period. In 1995, the system labour productivity (without import coefficient) was 8.95 million per thousand labour which increased to 129.7 in 2011. For the same sector, the system labour productivity with import coefficient increased from 9.02 million per thousand labour 1995 to 130.7 million per thousand labour in 2011. The trend of the system labour productivity indices entailed a negligible impact of trade on agricultural productivity.

System labour productivity in the mining sector was less than the industry labour productivity. The divergence between the system labour productivity and industry labour productivity for the sector has grown over the period. The system labour productivity indices of the sector had also increased gap. System labour productivity with import coefficient increased from 38.19 million per thousand persons in the year 1995 to 1538.09 million per thousand labour in the year 2011.

The sectoral linkages of the manufacturing sector are very strong with the rest of the world. The industry labour productivity was 158.12 million per thousand labour in 1995 and the system labour indices without and with import coefficient in 1995 were 27.49 million per thousand labour and 31.11 million per thousand labour respectively. The trend of increase in the sectors like textile products, leather products, wood products, paper products, non-metallic mineral products and Manufacturing n.e.c., and recycling has been similar as in these sectors the system labour productivity has increased from a period of decline. In other manufacturing sectors, the system labour productivity had grown steadily.

Electricity, gas & water supply, as well as, construction sectors, have recorded growth in system labour productivity. The divergence between of industry labour productivity and system labour productivity has also increased during the period of study. For the services sector, the system labour productivity without import coefficient increased from 35.97 million per thousand labour in 1995 to 465.90 million per thousand labour in 2011. The index with import coefficient increased from 38.22 million per thousand labour in 1995 to 508.6 million per thousand labour in 2011.

The mixed labour vector analysis shows whether the changes in input uses or changes in labour coefficient determine the productivity change. For Textile product, Leather product, Paper product, Non-metallic mineral product, Basic and non-ferrous metal products, Electrical and optical equipment, Transport equipment and Electricity, Gas and Water Supply sector, the increase in the system labour productivity as well as direct labour productivity was due to a falling tendency in the direct labour input combined with a rising tendency in the use of produced input over the period from 1995 to 1999. For period 1999-2004, the mixed labour vector condition is satisfied by leather product, paper product, non-metallic products, electrical and optical equipment, transport product and manufacturing nec., and recycling, and electricity, gas and water supply. In the case of wood product during the period, both the direct labour use and the use of produced inputs have declined. This caused an increase in system labour productivity in this sector. For the periods 2004 to 2011, the system labour productivity increased in all sectors except agriculture and allied activities due to the combined effect of falling direct labour use and produced input use. For agriculture and allied activities, the system productivity grew because of fall in the use of produced inputs. A mixed vector analysis for the entire period shows a fall in the produced inputs in agriculture and allied activities, mining, rubber, plastic and petroleum and construction sectors caused system productivity to grow. In other sectors, it is a combination of both falls in direct labour use and rise in use of produced input.

The system labour productivity analysis is also helpful in tracing the important sectors which have more employment potential. In most of the labour intensive sectors like agriculture & allied activities, textile product, leather product, wood product, paper product, non-metallic mineral product, manufacturing n.e.c., and recycling, the labour productivity has grown because of change in the input use but not due to change in labour coefficient. These sectors are also having greater employment potential.

6.2 Policy implications

From the study, it was found that the conventional approaches measuring productivity misrepresent the empirical reality for India. The estimation of Cobb-Douglas production function for the economy is misspecified. The use of aggregate production function for the economy could not give adequate policy prescriptions for the different diverse sectors. The more the diversification of the production structure, the more inadequate the representation of production functions. Chakravarty (1987: 39) had also warned against the use of aggregate production function. Plan models were only feasible only at high level of aggregation. But in practice, several variables are involved and the plans might not be carried out in a preferred course. The use of production function in the case of agricultural sector comes in sharp criticism as the structure of the sector is disaggregated in terms of techniques used, in terms of crop patterns, in terms of scattered fragmentation in land holdings, skill of labour used, fertility of the land etc. The significant share of unorganised manufacturing sector raises question on its application. For the organised manufacturing, one can assume homogenous technology in production process. But for the unorganised sector the technology used is more or less primitive. Again, the level of skill of labour is different. Thus, as the economic sectors are more unorganised in nature, policy makers should restrain from using aggregate production function.

System labour productivity goes beyond as an alternative and critique of conventional approach to productivity measurement. It gives insights on growth possibilities through unbalanced growth approach. India being troubled by jobless growth, the employment potential of the labour intensive manufacturing sector has to be realised. Strategic sectors in Indian economy are the labour intensive manufacturing and agriculture and allied activities. To develop an unbalanced growth strategy these sectors have to be taken care of seriously. These sectors directly help in employment generation and create demand for other sectors. The forward linkage of these sectors also helps in accumulation of capital for the other domestic capital-goods sector. The co-existence of highly advanced modern industries and pre-industrial industries in India deepens the question of direction of diversification of resources. It is uneconomical to invest in the advanced line of production existing in the developed countries (Hirschman, 1970). The comparative advantage of the labour-intensive pre-modern sector in India has to be realised.

From the analysis in the different chapters, it was found that most of the labour intensive sectors were the outliers. Sectors like Textile, Leather, Manufacturing nec., and Recycling, Non-metallic mineral products have performed poorly among the manufacturing industry groups. It is also found that for these manufacturing sectors the labour productivity growth has been slow and these are the sectors with ample employment generation capacity.

Textile sector continued to be one of the largest export-oriented manufacturing sectors. This sector employs around 3.5 crore people and is the second largest employment provider after the agriculture. It contributes about one-fifth of the total export earnings and also contributes around 4% of the GDP. Another important characteristic of this sector is being with high capital-employment ratio with immense potential of employment generation in the rural areas. The exports of the value-added products in the long-run have greater employment implications and also it invites more investments. The mega trade agreements between the USA and European union and other emerging exporters in the sector has to be negotiated through an integrated approach. Though the textile sector is well placed to provide employment, empower women, and promote inclusive growth and to develop Tier 2 and Tier 3 cities, several necessities to be assisted by the government. Infrastructural disabilities, the cascading effect of un-rebated taxes, high the cost of inputs and preferential benefits to the competitions are some problems to be solved by the Government and the domestic enterprises have to be assisted for some more time. (Texprocil press release)

The cost of funds and adverse impact of preferential access are some of the causes of export degradation in the recent years. TEXPROCIL urge the government to sign the FTAs with different countries to explore the export possibilities. Post Multi-Fibre Agreement, the textile industry needs to be more competitive. The export performance depends on the average cost as well as the productivity level. Indian textiles to be more competitive, the Indian rupees have to be devalued and to avoid such odd situation the productivity of the textile sector needs to be raised. Better capacity utilisation, reduction in nominal rate of protection and non-tariff barriers, increase in power availability, larger output size and credit disbursement would help the textile industry to revive.[1]

[1] Hashim: (2005, 126)

Hashim (2005) found technological retrogression in the cotton yarn industry and diseconomies of scale in the garment industry contributed to low productivity. He prescribed for large funds under Technological Upgradation Fund Scheme (TUFS), cheaper raw material, flexible labour laws for the improvement of productivity in the sub-sectors.[2]

The fragmentations in the Textile industry need to be realised. Power loom, Handloom, Cotton, Handicrafts, Woolen, Jute and Sericulture and silk sectors are the major subsectors within it. Handlooms, Handicrafts are mainly unorganised by nature. So the small unorganised firms should be encouraged to expand. The credit disbursement through TUFS should be promoted in SSIs to explore employment potential of the Textile sector.[3] IAMR report (2013) shows high employment elasticity for textile, leather, recycling, non-metallic mineral products and automobile equipment industry.

Another outlier sector was the Leather and footwear sector. The organised labour industry recorded low labour productivity growth while the unorganised leather industry has a substantially high increase in labour productivity.[4]The organised sector has become more resource and capital intensive and produced high TFPG while the unorganised sector successfully increased labour productivity. The leather sector grew drastically in the recent period not as an input supplier but as a finished good exporter.[5]

Gem and Jewellery which comes under the manufacturing n.e.c., and recycling has occupied a great share in the export. The Gem and Jewellery sector consists of a large number of SME units and also employs skilled as well as semiskilled labour. Another major characteristic is that they are majorly unorganised in nature.

The government has chalked out plans under the 12th five-year plan for these labour intensive manufacturing units and expected 70 million new jobs to be generated in these sectors.[6] The nature of the Indian labour market is largely unorganised. To generate more employment in such case, policy needs to take care of scale economies of production. The more rapid capital accumulation will invoke more employment. So the policy should aim at

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[2] Ibid: (127)

[3] IAMR Report no 11/2013.

[4] Working Group report/ 12th Five-year plan/Leather Industry. pp. 20.

[5] Council of Leather export, annual report 2014-15.

[6] Twelfth Five Year plan/Economic Sector/Vol II. pp. 95 and 123-128.

more and more industrial agglomeration in the labour-intensive sectors. The process will, in turn, due to high capital-labour ratio will augment labour productivity on one hand and the employment base of the country will expand on the other. A proper policy to labour market reforms will help in investment in labour intensive industries which would be helpful in generating employment. Also raising government savings will be critical for maintaining the level of investment and capital formation in the labour-intensive sectors.

6.3 Shortcomings of the study

A major part of the study is carried out for the period from 1995 to 2011. The Input-Output Transaction tables for India by WIOD are available for the same time period. The longevity of the time series may have some influence on the results of the econometric operations carried out in third chapter i.e. estimation of production function. A longer time series would have been reflected in improvement in the results. Another shortcoming of the study is the mismatch of the time point available for different data sets. The NSSO employment survey is carried out in every five years whereas NAS and ASI data are available on annual basis. So to make the analysis comparable different methods of measuring growth are adopted.

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Appendix Tables

Table A3.1: Cobb-Douglas Production Function (Single Deflation)

	Agriculture and Allied Activities	Mining and Quarrying	Food Products	Textile Products	Leather products	Wood Products	Paper Products	Rubber, Plastic and Petroleum	Chemical Products
α	-22.52	4.53	-17.45	1.25	4.86	23.72	-7.48	10.02	5.98
t(α)	-3.68	3.27	-3.99	1.20	3.98	2.99	-0.55	1.31	1.71
βl	0.86	0.74	1.06	0.22	-0.32	-4.45	0.23	0.39	-0.01
t(βl)	2.21	2.85	5.76	3.38	-3.38	-3.84	0.31	0.40	-0.10
βk	1.79	0.09	1.42	0.70	0.66	2.28	1.29	-0.19	0.44
t(βk)	11.06	0.65	6.92	9.74	9.01	6.72	1.89	-0.40	1.64
βt	**-0.05**	**0.21**	**0.01**	**0.00**	**0.05**	**-0.20**	**-0.01**	**0.28**	**0.10**
t(βt)	-2.88	11.19	0.71	0.55	4.06	-4.09	-0.15	3.28	3.03
Adjusted R-squared	0.99	0.99	1.00	0.99	0.99	0.66	0.99	0.96	1.00
F-statistic	642.93	894.96	1379.58	647.42	585.51	9.88	372.82	110.16	1041.02
D-W Stat	1.09	2.97	2.01	2.14	2.14	0.96	1.30	1.36	1.88

	Non-Metallic Mineral	Basic and Non-Ferrous metal	Electrical and Optical Equipment	Transport Equipment	Manufacturing, Nec, Recycling	Manufacturing	Electricity, Gas and Water Supply	Construction	Services
α	-9.37	2.61	8.82	-3.80	20.17	-11.69	-6.20	9.66	5.34
t(α)	-1.12	0.67	1.14	-0.57	4.58	-1.73	-1.61	2.05	0.40
βl	0.37	-0.63	-0.89	1.52	-2.15	0.58	-0.46	-1.37	-0.66
t(βl)	0.61	-1.62	-2.64	2.38	-4.70	1.40	-2.41	-8.97	-1.20
βk	1.38	1.09	0.71	0.47	0.70	1.28	1.52	1.36	1.09
t(βk)	4.93	13.90	1.61	1.82	5.17	7.67	7.08	3.17	2.23
βt	**-0.03**	**0.03**	**0.08**	**-0.04**	**0.13**	**-0.02**	**-0.01**	**0.04**	**0.06**
t(βt)	-0.62	1.82	1.62	-0.49	3.62	-0.78	-0.83	0.50	0.82
Adjusted R-squared	0.98	1.00	0.99	0.97	0.98	1.00	0.99	1.00	1.00
F-statistic	271.23	1221.52	533.66	168.28	247.95	1362.90	764.81	1262.62	1623.96
D-W Stat	1.97	1.74	2.26	1.93	1.67	0.72	1.37	1.54	0.55

Source: Estimated from data collected from NIOT and Socio Economic Accounts published by WIOD.

Deflator Used: GDP deflator, 2004-05

Note: Regression is carried out with HAC (Newey-West) estimator.

Table A3.2: Cobb-Douglas Production Function (Double Deflation)

	Agriculture and Allied Activities	Mining and Quarrying	Food Products	Textile Products	Leather Products	Wood Products	Paper Products	Rubber, Plastic and Petroleum	Chemical Products
α	-71.83	-40.49	169.47	-85.92	-48.26	65.76	186.17	81.88	192.52
t(α)	-0.25	-1.16	1.96	-2.82	-2.03	2.82	3.23	3.17	7.01
βl	4.53	6.02	-10.11	5.00	6.74	-3.87	-15.40	-1.71	-3.07
t(βl)	0.26	1.37	-2.43	2.96	3.02	-0.86	-2.86	-0.51	-4.92
βk	1.90	0.47	-4.62	4.10	1.89	-1.87	-5.04	-4.58	-11.88
t(βk)	0.39	0.49	-1.21	2.28	1.86	-0.76	-1.36	-3.38	-5.37
βt	**-0.23**	**-0.07**	**0.33**	**-0.78**	**-0.64**	**0.32**	**1.07**	**0.80**	**1.24**
t(βt)	-0.42	-0.42	0.92	-3.08	-2.54	1.02	2.60	3.55	4.53
Adjusted R-squared	-0.28	-0.04	0.25	0.26	0.33	0.23	0.05	0.29	0.72
F-statistic	0.04	0.83	2.48	2.51	3.17	2.40	1.26	2.87	12.91
D-W Stat	1.84	2.49	2.47	2.79	2.62	2.13	1.49	2.45	2.75

	Non-Metallic Mineral	Basic and Non-Ferrous metal	Electrical & Optical Equipment	Transport Equipment	Manufacturing, Nec, Recycling	Manufacturing	Electricity, Gas and Water Supply	Construction	Services
α	-110.32	288.93	362.31	-61.09	-188.32	-11.81	-129.69	84.15	-354.49
t(α)	-0.63	2.38	6.99	-2.17	-4.58	-0.98	-4.33	1.46	-0.78
βl	8.95	-26.38	-19.29	12.78	19.64	0.80	18.94	-1.30	15.72
t(βl)	0.66	-2.57	-7.86	4.52	5.34	1.11	9.95	-0.21	0.91
βk	3.99	-3.75	-16.81	-0.43	3.93	1.14	0.73	-4.97	12.11
t(βk)	0.77	-1.28	-5.90	-0.37	2.36	3.57	0.40	-1.16	0.68
βt	**-0.78**	**0.68**	**1.63**	**-0.92**	**-1.51**	**-0.02**	**-0.15**	**1.02**	**-1.95**
t(βt)	-0.79	1.49	5.43	-2.68	-3.92	-0.33	-0.95	1.35	-0.75
Adjusted R-squared	-0.15	0.14	0.70	0.58	0.46	0.99	0.75	-0.22	-0.19
F-statistic	0.40	1.74	12.07	7.56	5.03	391.13	14.86	0.16	0.24
D-W Stat	1.23	1.36	2.82	2.09	2.22	0.87	2.45	0.93	1.14

Source: Estimated from data collected from NIOT and Socio-Economic Accounts published by WIOD.

Deflator Used: GDP deflator, 2004-05

Note: Regression is carried out with HAC (Newey-West) estimator.

Table A3.3: CES production Function: (Single deflation)

	Agriculture and Allied Activities	Mining and Quarrying	Food Products	Textiles Products	Leather Products	Wood Products	Paper, Products	Rubber, Plastic and Petroleum	Chemical Products
β1	176.88	75.15	302.84	76.92	130.68	136.31	97.02	9.70	188.26
t (β1)	0.63	0.88	1.93	0.48	1.03	1.72	0.56	0.20	3.83
β2	43.45	33.87	-22.26	53.06	42.34	-34.40	-49.00	32.38	-4.06
t (β2)	2.63	1.32	-2.45	1.23	1.58	-1.13	-0.83	1.35	-0.41
β3	-49.84	-29.37	-6.22	-48.25	-42.36	16.76	26.76	-22.76	-10.87
t (β3)	-2.00	-1.17	-0.89	-1.01	-1.32	0.94	0.48	-1.72	-1.07
β4	6.05	1.98	-0.22	5.44	3.77	-3.17	-2.48	1.77	-0.06
t (β4)	2.28	1.19	-0.51	1.12	1.36	-1.11	-0.59	1.43	-0.10
α	**1.17**	**0.77**	**0.85**	**-0.40**	**0.07**	**1.02**	**1.12**	**0.18**	**1.21**
t(α)	1.23	1.08	1.50	-0.77	0.14	1.71	3.10	0.47	3.27
Efficiency parameter	6.6E+76	4.3E+32	3.3E+131	2.6E+33	5.69E+56	1.6E+59	1.4E+42	16322.7	5.7E+81
Scale parameter	-6.39	4.51	-28.48	4.81	-0.02	-17.64	-22.23	9.62	-14.93
Distribution parameter	7.80	-6.51	0.22	-10.04	1756.98	-0.95	-1.20	-2.37	0.73
Substitution parameter	-0.04	0.02	-0.09	0.02	0.00	0.19	0.08	0.05	-0.04
Elasticity of substitution	1.04	0.98	1.10	0.98	1.00	0.84	0.92	0.96	1.04
Adjusted R-Square	0.17	-0.02	0.27	0.28	0.40	0.23	-0.01	0.37	0.69
F Stat	1.65	0.94	2.22	2.25	3.16	2.07	0.97	3.06	8.81
D-W Stat	2.68	2.69	2.59	2.98	2.96	2.08	1.56	2.61	2.76

	Non-Metallic Mineral	Basic and Non-Ferrous metal	Electrical and Optical Equipment	Transport Equipment	Manufacturing, Nec; Recycling	Manufacturing	Electricity, Gas and Water Supply	Construction	Services
β1	187.80	380.07	335.10	96.51	-153.77	-6.95	-116.65	-141.19	572.61
t (β1)	0.71	2.46	3.71	1.56	-3.07	-0.30	-1.44	-1.02	1.81
β2	63.09	-13.80	-22.94	34.78	29.23	1.59	20.83	39.36	142.78
t (β2)	1.71	-1.40	-2.59	3.97	2.61	0.82	1.58	2.43	3.74
β3	-62.46	-20.48	-11.85	-30.97	-6.92	0.17	-1.62	-19.83	-151.10
t (β3)	-1.52	-1.72	-0.95	-2.75	-0.58	0.06	-0.11	-5.19	-4.01
β4	5.28	1.18	-0.31	2.20	1.11	0.08	0.14	3.24	10.74
t (β4)	1.60	1.61	-0.43	2.75	0.93	0.35	0.16	2.57	4.06
α	**0.31**	**0.98**	**1.53**	**-0.14**	**-1.29**	**0.00**	**-0.13**	**-1.38**	**3.82**
t(α)	0.25	1.68	3.43	-0.34	-3.12	0.00	-0.76	-0.77	2.15
Efficiency parameter	3.6E+81	1.1E+165	3.4E+145	8.2E+41	1.7E-67	0.001	2.2E-51	4.8E-62	4.8E+248
Scale parameter	0.63	-34.28	-34.79	3.82	22.31	1.76	19.21	19.53	-8.32
Distribution parameter	-99.19	0.60	0.34	-8.11	-0.31	0.10	-0.08	-1.02	18.16
Substitution parameter	0.00	0.29	-0.08	0.02	0.24	-0.99	0.16	0.16	-0.01
Elasticity of substitution	1.00	0.78	1.09	0.98	0.80	69.25	0.86	0.86	1.01
Adjusted R-Square	0.01	0.10	0.68	0.66	0.45	0.99	0.72	0.23	0.44
F Stat	1.03	1.38	8.29	7.74	3.83	274.56	10.14	2.07	3.78
D-W Stat	1.34	1.36	2.81	2.26	2.22	0.92	2.47	1.55	2.85

Source: Estimated from data collected from NIOT and Socio-Economic Accounts published by WIOD.

Deflator Used: GDP deflator, 2004-05

Note: Regression is carried out with HAC (Newey-West) estimator.

Table A3.4: CES production Function (Double deflation)

	Agriculture and Allied Activities	Mining and Quarrying	Food Products	Textile Products	Leather Products	Wood Products	Paper Products	Rubber, Plastic and Petroleum	Chemical Products
β1	-42.13	-13.16	-19.94	-2.98	2.69	-4.77	-33.12	-16.00	12.35
t (β1)	-6.09	-3.09	-6.85	-0.53	0.47	-0.25	-2.43	-1.36	2.84
β2	-1.44	-3.38	-0.68	-1.07	-0.84	7.88	-9.44	12.68	1.47
t (β2)	-2.69	-2.92	-1.43	-0.61	-0.62	1.19	-5.62	2.96	2.56
β3	5.19	4.55	2.99	2.10	1.27	-5.25	10.44	-6.75	-1.07
t (β3)	15.55	3.94	5.71	1.11	0.81	-1.41	4.76	-3.08	-1.64
β4	-0.39	-0.30	-0.14	-0.15	-0.05	1.28	-0.71	0.64	0.09
t (β4)	-9.96	-3.96	-3.48	-0.74	-0.39	2.00	-4.96	3.20	2.73
α	**-0.15**	**0.09**	**0.00**	**0.00**	**0.04**	**-0.48**	**0.00**	**0.06**	**0.14**
t(α)	-9.54	2.21	0.06	-0.34	2.06	-2.96	0.00	0.76	3.60
Efficiency parameter	5.1E-19	1.9E-06	2.2E-09	5.1E-02	1.5E+01	8.5E-03	4.1E-15	1.1E-07	2.3E+05
Scale parameter	3.75	1.17	2.31	1.03	0.43	2.63	1.00	5.93	0.40
Distribution parameter	1.38	3.89	1.30	2.03	2.98	-2.00	10.40	-1.14	-2.69
Substitution parameter	-0.39	-0.04	-0.32	-0.13	-0.04	0.16	-0.01	0.09	0.04
Elasticity of substitution	1.65	1.05	1.47	1.16	1.04	0.86	1.01	0.92	0.96
Adjusted R-Square	1.00	1.00	1.00	0.99	0.99	0.67	0.99	0.97	1.00
F Stat	1602.41	1295.58	1577.40	465.36	405.74	8.21	544.45	122.62	852.38
D-W Stat	2.90	2.58	2.54	2.12	2.20	1.17	1.96	1.03	2.10

	Non-Metallic Mineral	Basic and Non-Ferrous metal	Electrical and Optical Equipment	Transport Equipment	Manufacturing, Nec; Recycling	Manufacturing	Electricity, Gas and Water Supply	Construction	Services
β1	6.50	-0.76	8.56	29.35	26.84	-2.55	-23.36	12.07	-23.60
t (β1)	0.31	-0.10	0.55	2.53	7.76	-0.36	-3.33	1.20	-4.62
β2	3.26	-1.09	-0.93	6.15	-0.30	2.07	-2.96	-1.81	-4.63
t (β2)	0.90	-1.80	-0.66	5.07	-0.27	2.09	-3.54	-2.02	-3.88
β3	-2.16	1.71	0.76	-5.95	-1.39	-0.56	4.61	1.52	6.18
t (β3)	-0.50	2.32	0.35	-3.28	-1.51	-0.52	4.22	7.15	6.12
β4	0.28	-0.04	0.00	0.46	0.21	0.14	-0.18	-0.03	-0.34
t (β4)	0.83	-0.83	-0.02	3.64	2.20	1.66	-3.07	-0.48	-4.20
α	**0.02**	**0.01**	**0.07**	**0.12**	**0.17**	**0.01**	**-0.03**	**0.07**	**-0.12**
t(α)	0.27	0.69	0.99	1.42	4.96	0.38	-1.85	0.47	-4.36
Efficiency parameter	6.7E+02	4.7E-01	5.2E+03	5.6E+12	4.5E+11	7.8E-02	7.1E-11	1.8E+05	5.6E-11
Scale parameter	1.09	0.62	-0.17	0.20	-1.69	1.51	1.66	-0.29	1.55
Distribution parameter	-1.98	2.76	-4.41	-30.42	0.82	-0.37	2.78	-5.31	3.99
Substitution parameter	0.09	-0.03	0.00	0.00	1.75	0.37	-0.04	0.01	-0.04
Elasticity of substitution	0.92	1.03	1.00	1.00	0.36	0.73	1.05	0.99	1.04
Adjusted R-Square	0.98	1.00	0.99	0.98	0.98	1.00	1.00	1.00	1.00
F Stat	206.06	856.33	363.88	215.39	208.45	1367.84	761.95	882.69	3405.58
D-W Stat	1.98	1.71	2.26	2.14	1.94	0.89	1.51	1.68	1.66

Source: Estimated from data collected from NIOT and Socio-Economic Accounts published by WIOD.

Deflator Used: GDP deflator, 2004-05

Note: Regression is carried out with HAC (Newey-West) estimator.

Table A3.5: Translog Production Function (1995-2009, Single Deflation)

	Agriculture and allied activities	Mining and Quarrying	Food Products	Textile Products	Leather Product	Wood Products
β0	-4524.56	335.54	242.88	-435.11	-678.36	-103.75
t(β0)	-2.05	1.02	0.11	-0.41	-1.05	-0.35
βl	517.26	-130.25	-110.66	28.93	106.55	103.90
t(βl)	2.16	-1.24	-0.54	0.40	0.82	0.93
βk	177.01	26.09	37.58	45.77	66.95	-62.29
t(βk)	0.85	0.77	0.17	0.38	1.30	-0.94
βt	**-17.86**	**-1.55**	**0.63**	**-2.77**	**-13.40**	**15.36**
t(βt)	-0.90	-0.32	0.03	-0.16	-1.02	1.68
βll	-15.65	15.40	6.51	-0.80	-3.39	-12.10
t(βll)	-1.49	1.87	0.98	-0.86	-0.59	-0.84
βkk	-2.20	1.74	-1.02	-1.30	-1.42	-0.40
t(βkk)	-0.73	1.23	-0.20	-0.39	-1.30	-0.12
βlk	-8.75	-8.65	-0.69	-1.07	-5.96	8.98
t(βlk)	-0.86	-3.46	-0.07	-0.23	-1.03	0.67
βlt	**1.00**	**1.19**	**0.04**	**0.07**	**0.92**	**-0.94**
t(βlt)	1.10	2.72	0.04	0.15	0.77	-0.63
βkt	0.36	-0.61	-0.09	0.15	0.73	-0.74
t(βkt)	0.54	-1.25	-0.10	0.14	1.18	-0.98
βtt	-0.02	0.04	0.02	0.00	-0.07	0.12
t(βtt)	-0.49	1.01	0.46	0.05	-1.00	2.31
Adj R-Square	1.00	1.00	1.00	0.99	0.99	0.90
DW Stat	722.08	1102.25	787.99	135.13	220.04	15.34
F-Stat	3.17	2.85	3.13	2.33	3.05	2.46

	Paper products	Rubber, Plastic and Petroleum	Chemical Products	Non-Metallic Mineral	Basic and Non-Ferrous metal	Electrical and Optical Equipment
β0	-8817.84	-1943.28	-292.96	9450.65	-9611.61	-20970.25
t(β0)	-2.17	-3.26	-0.31	2.81	-1.52	-1.53
βl	1320.78	548.51	-56.98	-1578.13	1671.19	1742.74
t(βl)	2.50	4.11	-3.88	-2.80	1.64	1.32
βk	644.83	-21.28	76.78	-477.02	369.41	2357.69
t(βk)	1.54	-0.43	0.52	-2.25	1.22	1.63
βt	**-108.78**	**-3.89**	**-10.44**	**104.08**	**-64.77**	**-243.92**
t(βt)	-1.86	-0.36	-0.61	2.71	-1.32	-1.75
βll	-44.45	-24.05	0.53	60.78	-71.77	-34.04
t(βll)	-2.01	-2.81	0.10	2.42	-1.76	-1.27
βkk	-10.17	5.21	-3.92	3.91	-3.09	-65.46
t(βkk)	-0.81	2.42	-0.75	0.92	-0.93	-1.77
βlk	-53.88	-14.47	3.76	46.51	-33.29	-100.50
t(βlk)	-2.76	-1.61	0.69	2.98	-1.33	-1.34
βlt	**8.48**	**2.53**	**-0.45**	**-9.30**	**5.96**	**10.46**
t(βlt)	2.43	1.45	-0.55	-3.08	1.47	1.40
βkt	**3.79**	**-1.20**	**1.05**	**-2.24**	**1.03**	**13.53**
t(βkt)	1.21	-1.74	0.81	-1.64	0.93	1.88
βtt	**-0.33**	**0.06**	**-0.07**	**0.28**	**-0.09**	**-0.70**
t(βtt)	-1.56	1.04	-0.89	2.36	-1.00	-1.96
Adj R-Square	1.00	0.99	1.00	0.99	1.00	0.99
DW Stat	379.29	207.69	352.74	103.15	692.42	212.03
F-Stat	2.82	3.36	3.28	1.84	3.66	3.18

	Transport Equipment	Manf Nec, Recycling	Manf.	Elect. Gas and Water Supply	Const.	Services
β0	2566.12	-2448.04	1324.01	3079.70	-3683.93	20351.83
t(β0)	1.92	-1.54	0.25	2.04	-0.71	1.24
βl	-471.11	376.06	-86.26	-289.52	-375.23	-1406.12
t(βl)	-2.11	1.62	-0.15	-1.76	-0.47	-1.15
βk	-175.33	174.35	-112.83	-287.44	947.87	-1567.20
t(βk)	-1.62	0.95	-0.37	-2.10	0.75	-1.28
βt	**60.95**	**-53.83**	**16.10**	**26.21**	**-164.26**	**225.82**
t(βt)	2.05	-1.53	0.31	2.19	-0.76	1.24
βll	19.46	-16.15	-1.03	4.26	8.72	41.38
t(βll)	2.56	-1.07	-0.07	1.01	0.28	2.82
βkk	2.39	-4.11	1.27	6.18	-48.38	39.14
t(βkk)	1.08	-0.77	0.32	2.12	-0.79	2.15
βlk	18.53	-10.62	7.08	15.94	18.04	29.46
t(βlk)	1.62	-1.10	0.40	1.94	0.91	0.48
βlt	**-5.64**	**3.60**	**-0.74**	**-1.27**	**-4.92**	**-5.69**
t(βlt)	-2.35	2.15	-0.26	-1.91	-0.66	-0.71
βkt	**-2.08**	**2.27**	**-0.54**	**-1.21**	**18.27**	**-10.22**
t(βkt)	-1.67	1.00	-0.38	-2.30	0.78	-1.82
βtt	**0.37**	**-0.30**	**0.05**	**0.06**	**-1.67**	**0.69**
t(βtt)	2.14	-1.37	0.39	2.38	-0.77	1.51
Adj R-Square	0.99	0.99	1.00	1.00	0.99	1.00
DW Stat	138.94	115.77	709.61	520.67	269.69	1924.43
F-Stat	2.47	2.95	2.12	2.68	2.19	2.17

Source: Estimated from data collected from NIOT and Socio Economic Accounts published by WIOD.

Deflator Used: GDP deflator, 2004-05

Note: Regression is carried out with HAC (Newey-West) estimator.

Table A3.6: Translog Production Function (1995-2009, Double Deflation)

	Agriculture and allied activities	Mining and Quarrying	Food Products	Textile Products	Leather Product	Wood Products
β0	-841324.30	-15048.50	60061.23	-47404.83	20300.28	893.59
t(β0)	-0.86	-0.59	1.02	-3.94	2.74	0.52
βl	109939.70	2536.09	-8096.26	2890.93	-3881.39	-1252.08
t(βl)	0.89	0.60	-1.06	5.02	-2.70	-1.18
βk	21893.42	836.05	-3358.54	5245.55	-1548.44	815.23
t(βk)	0.75	0.34	-0.78	3.52	-1.96	1.10
βt	**-3002.30**	**-96.46**	**382.88**	**-707.89**	**374.68**	**-117.89**
t(βt)	-0.81	-0.27	0.93	-3.41	2.19	-1.19
βll	-3562.02	-106.74	277.32	-26.55	168.11	116.99
t(βll)	-0.90	-0.37	1.25	-2.31	2.32	0.83
βkk	-119.76	-12.47	49.90	-138.33	24.06	-11.75
t(βkk)	-0.55	-0.20	0.57	-2.88	0.99	-0.45
βlk	-1482.20	-68.87	219.12	-181.71	167.76	-66.70
t(βlk)	-0.80	-0.46	0.75	-4.48	2.58	-0.54
βlt	**204.13**	**8.16**	**-21.32**	**17.88**	**-35.61**	**7.18**
t(βlt)	0.85	0.36	-0.69	4.33	-2.67	0.58
βkt	**32.13**	**2.48**	**-14.01**	**41.68**	**-14.48**	**5.28**
t(βkt)	0.62	0.14	-0.90	3.08	-1.35	0.71
βtt	**-2.16**	**0.15**	**1.05**	**-2.67**	**1.78**	**-0.48**
t(βtt)	-0.69	0.17	1.43	-2.87	1.72	-0.80
Adj R-Square	-0.01	-0.44	0.53	0.83	0.08	0.44
DW Stat	0.98	0.56	2.66	8.20	1.12	2.23
F-Stat	3.34	2.69	2.71	2.59	3.05	3.47

	Paper Product	Rubber, Plastic and Petroleum	Chemical Products	Non-Metallic Mineral	Basic and Non-Ferrous metal	Electrical and Optical Equipment
β0	119540.40	3543.95	-9402.90	-60056.64	77223.33	89183.06
t(β0)	1.77	0.66	-0.90	-1.43	0.99	0.77
βl	-15301.25	-1051.41	-92.04	11902.86	-12403.12	-4858.24
t(βl)	-1.59	-0.85	-0.43	1.60	-0.99	-0.46
βk	-10207.88	87.05	1506.24	1843.52	-3610.66	-11557.07
t(βk)	-1.84	0.12	0.94	0.91	-0.95	-0.92
βt	**1630.51**	**-46.21**	**-179.63**	**-558.97**	**622.14**	**1354.55**
t(βt)	1.87	-0.31	-0.87	-1.21	1.02	1.10
βll	616.57	29.29	28.27	-516.68	525.30	99.37
t(βll)	1.80	0.25	0.36	-1.53	1.05	0.45
βkk	256.36	-17.92	-51.78	15.69	53.71	385.47
t(βkk)	1.99	-1.93	-0.78	0.48	1.22	1.17
βlk	513.75	47.18	-23.68	-275.94	254.62	276.57
t(βlk)	1.35	0.50	-0.27	-1.69	0.82	0.46
βlt	**-99.34**	**-3.09**	**1.93**	**64.12**	**-43.50**	**-34.33**
t(βlt)	-1.62	-0.17	0.16	1.64	-0.88	-0.56
βkt	**-72.42**	**5.51**	**12.99**	**2.94**	**-18.71**	**-89.18**
t(βkt)	-1.95	1.61	0.70	0.23	-1.31	-1.39
βtt	**5.63**	**-0.36**	**-1.03**	**-1.00**	**1.61**	**5.08**
t(βtt)	1.96	-1.08	-0.92	-0.74	1.38	1.62
Adj R-Square	0.71	0.25	0.59	0.64	0.60	0.67
DW Stat	4.83	1.53	3.23	3.76	3.37	4.14
F-Stat	2.89	2.84	3.40	2.11	3.01	3.45

	Transport Equipment	Manf. Nec, Recycling	Manf.	Elect., Gas and Water Supply	Const.	Services
β0	-14791.25	2455.01	146.13	17104.78	62980.69	-1319932.00
t(β0)	-1.47	0.39	0.01	0.93	2.65	-1.30
βl	2889.80	2625.47	69.23	-2062.77	8619.38	111079.10
t(βl)	1.73	1.99	0.04	-1.03	3.15	1.70
βk	971.07	-2330.12	-63.78	-1397.69	-17957.42	87408.84
t(βk)	1.24	-2.95	-0.08	-0.83	-5.04	1.06
βt	**-381.11**	**305.25**	**-0.11**	**152.16**	**2970.13**	**-13187.10**
t(βt)	-1.77	2.53	0.00	1.11	4.18	-1.13
βll	-162.21	-206.59	-11.02	80.71	-299.93	-1476.10
t(βll)	-3.02	-2.16	-0.27	1.52	-2.59	-1.78
βkk	-21.53	85.54	-1.64	32.68	882.08	-1006.38
t(βkk)	-1.63	4.71	-0.18	0.83	5.31	-0.62
βlk	-72.86	57.30	10.68	66.87	-255.56	-4909.77
t(βlk)	-0.77	0.86	0.22	0.68	-3.64	-1.55
βlt	**38.35**	**12.82**	**-0.34**	**-8.19**	**99.08**	**650.89**
t(βlt)	2.21	1.19	-0.04	-1.23	4.19	1.57
βkt	**11.72**	**-36.77**	**0.26**	**-6.64**	**-338.49**	**367.83**
t(βkt)	1.33	-4.82	0.08	-0.95	-5.25	0.78
βtt	**-2.32**	**3.10**	**-0.02**	**0.32**	**30.72**	**-30.15**
t(βtt)	-1.93	4.71	-0.07	1.04	4.93	-0.91
Adj R-Square	0.67	0.81	0.99	0.69	0.89	0.35
DW Stat	4.19	7.75	145.50	4.47	13.35	1.85
F-Stat	3.33	3.11	1.93	3.00	2.69	2.36

Source: Estimated from data collected from NIOT and Socio Economic Accounts published by WIOD.

Deflator Used: GDP deflator, 2004-05

Note: Regression is carried out with HAC (Newey-West) estimator.

Table A3.7: Cobb-Douglas Production Function for Registered Manufacturing (1980-81 to 2012-13, Single Deflation)

	Food Processing	Textile Products	Leather Products	Wood Products	Paper, Products	Rubber, Plastic and Petroleum	Chemical Products
α	9.47	-0.31	-0.49	-0.70	6.62	10.23	-5.62
t(α)	3.83	-0.25	-0.27	-0.43	5.29	1.79	-2.42
βl	-0.67	0.79	0.61	0.11	0.50	0.08	1.04
t(βl)	-2.38	6.27	3.52	0.39	4.84	0.15	4.74
βk	1.01	0.20	0.40	0.98	-0.04	0.13	0.39
t(βk)	5.67	3.84	6.10	4.83	-0.54	1.00	6.03
βt	**-0.01**	**0.03**	**0.01**	**-0.03**	**0.05**	**0.08**	**0.02**
t(βt)	-1.02	6.40	1.59	-2.82	12.74	4.14	4.86
Adjusted R-squared	0.98	0.97	0.97	0.90	0.97	0.95	0.99
F-statistic	473.82	366.38	389.52	100.43	320.17	192.77	1005.78
D-W Stat	1.34	1.41	1.60	1.75	1.68	1.11	1.48

	Non-Metallic Mineral	Basic and Non-Ferrous metal	Electrical and Optical Equipment	Transport Equipment	Manufacturing, Nec; Recycling	Manufacturing
α	-8.01	2.65	-0.68	1.50	3.60	0.40
t(α)	-2.06	1.59	-0.39	0.66	0.91	0.23
βl	1.15	0.69	0.77	0.68	0.31	0.97
t(βl)	4.67	5.16	4.66	3.74	0.77	7.37
βk	0.43	0.12	0.28	0.19	0.35	0.00
t(βk)	4.53	1.87	3.43	1.22	7.14	0.01
βt	**0.02**	**0.05**	**0.04**	**0.06**	**0.04**	**0.06**
t(βt)	1.24	9.85	5.27	3.81	1.38	9.07
Adjusted R-squared	0.97	0.98	0.99	0.97	0.95	1.00
F-statistic	329.18	453.84	987.98	331.04	198.78	2673.20
D-W Stat	1.16	1.40	1.46	0.98	1.46	1.29

Source: Data collected from Annual Survey of Industries (ASI)

Deflator Used: GDP deflator at 2004-05 prices.

Note: Regression is carried out with HAC (Newey-West) estimator.

Table A3.8: Cobb-Douglas Production Function for Registered Manufacturing (1995-2011, Single Deflation)

	Food Products	Textile Products	Leather Products	Wood Products	Paper Products	Rubber, Plastic and Petroleum	Chemical Products
α	4.83	1.66	-1.31	-1.62	6.77	7.76	-7.03
t(α)	1.45	1.61	-0.71	-1.87	4.18	1.13	-3.09
βl	0.01	0.46	0.73	0.64	0.68	0.55	1.16
t(βl)	0.03	4.58	1.99	1.78	2.85	1.01	5.15
βk	0.64	0.40	0.38	0.49	-0.15	-0.02	0.40
t(βk)	2.26	9.48	1.11	1.70	-0.85	-0.20	4.74
βt	**0.01**	**0.03**	**0.01**	**0.01**	**0.06**	**0.07**	**0.02**
t(βt)	0.57	10.23	0.54	0.62	6.82	3.40	5.11
Adjusted R-squared	0.92	0.98	0.95	0.96	0.91	0.80	0.94
F-statistic	64.57	222.96	96.95	132.32	52.11	22.38	83.86
D-W Stat	1.92	2.16	1.85	2.55	2.19	1.13	2.04

	Non-Metallic Mineral	Basic and Non-Ferrous metal	Electrical and Optical Equipment	Transport Equipment	Manufacturing, Nec; Recycling	Manufacturing
α	-9.21	2.99	0.78	4.62	-2.70	-0.09
t(α)	-2.97	1.27	0.37	1.50	-0.54	-0.07
βl	1.10	0.67	0.70	0.82	0.95	1.24
t(βl)	4.13	2.86	3.91	5.65	1.98	6.97
βk	0.58	0.17	0.28	-0.11	0.35	-0.17
t(βk)	4.81	1.56	2.72	-0.47	10.69	-1.17
βt	**0.01**	**0.05**	**0.05**	**0.09**	**-0.02**	**0.06**
t(βt)	0.74	7.73	5.52	3.32	-0.41	8.07
Adjusted R-squared	0.93	0.94	0.95	0.90	0.94	0.99
F-statistic	71.46	83.09	107.14	47.44	78.41	417.64
D-W Stat	1.44	1.72	1.25	1.60	1.77	1.95

Source: Data collected from Annual Survey of Industries (ASI)

Deflator Used: GDP deflator at 2004-05 prices.

Note: Regression is carried out with HAC (Newey-West) estimator.

Table A3.9: Cobb-Douglas Production Function for Registered Manufacturing (1995-2011, Double Deflation)

	Food Products	Textiles Products	Leather Products	Wood Products	Paper Products	Rubber, Plastic and Petroleum	Chemical Products
α	11.47	11.26	-1.89	-4.01	3.99	-18.91	-14.66
t(α)	1.11	4.16	-0.33	-0.61	1.49	-2.18	-3.48
βl	-1.81	-1.22	0.34	0.06	0.48	2.04	1.82
t(βl)	-1.25	-3.36	0.33	0.03	1.17	2.97	4.45
βk	1.97	1.32	0.76	1.19	0.21	0.55	0.31
t(βk)	2.44	6.82	0.86	0.91	0.73	1.53	1.62
βt	**-0.05**	**0.08**	**0.06**	**0.03**	**0.06**	**-0.11**	**0.03**
t(βt)	-1.19	11.01	1.82	0.32	3.82	-3.06	3.87
Adjusted R-squared	0.82	0.98	0.89	0.64	0.87	0.47	0.94
F-statistic	24.54	211.16	43.87	10.32	36.14	5.73	81.29
D-W Stat	1.43	1.35	1.33	1.72	1.32	1.93	1.81

	Non-Metallic Mineral	Basic and Non-Ferrous metal	Electrical and Optical Equipment	Transport Equipment	Manufacturing, Nec; Recycling	Manufacturing
α	-0.82	6.13	-0.28	-0.09	-2.50	-10.06
t(α)	-0.21	4.51	-0.09	-0.03	-0.48	-4.62
βl	0.08	0.06	0.47	1.36	0.95	1.28
t(βl)	0.21	0.39	2.25	5.10	1.89	6.54
βk	0.86	0.52	0.52	-0.31	0.31	0.36
t(βk)	3.81	6.32	2.21	-1.28	3.83	2.27
βt	**0.08**	**0.04**	**0.10**	**0.16**	**0.02**	**0.05**
t(βt)	4.14	8.69	6.27	6.49	0.53	5.78
Adjusted R-squared	0.94	0.97	0.97	0.94	0.95	0.99
F-statistic	79.95	184.06	179.22	85.18	97.76	527.86
D-W Stat	1.48	2.32	1.38	1.71	2.29	1.95

Source: Data collected from Annual Survey of Industries (ASI)

Deflator Used: GDP deflator at 2004-05 prices.

Note: Regression is carried out with HAC (Newey-West) estimator.

Table A3.10: CES Production Function for Registered Manufacturing (1980-81 to 2012-13, Single Deflation)

	Food Products	Textile Products	Leather Products	Wood Products	Paper Products	Rubber, Plastic and Petroleum	Chemical Products
β1	7.56	-1.23	-1.43	2.43	6.03	8.03	-6.49
t (β1)	4.59	-0.75	-0.77	0.97	4.17	1.49	-2.62
β2	-0.47	0.85	0.69	-0.01	0.40	-0.69	0.70
t (β2)	-2.53	6.29	3.82	-0.02	2.21	-1.29	2.26
β3	0.94	0.21	0.42	0.82	0.10	1.01	0.78
t (β3)	5.94	3.72	12.74	3.56	0.54	4.24	2.91
β4	-0.06	-0.03	-0.28	0.30	-0.05	-0.20	-0.11
t (β4)	-1.50	-0.55	-3.44	1.61	-0.90	-3.95	-1.37
α	**-0.01**	**0.03**	**0.01**	**-0.03**	**0.05**	**0.08**	**0.02**
t(α)	-0.45	6.38	1.14	-2.64	12.45	4.09	3.87
Efficiency parameter	1.9E+03	2.9E-01	2.4E-01	1.1E+01	4.2E+02	3.1E+03	1.5E-03
Scale parameter	0.47	1.05	1.11	0.81	0.51	0.32	1.48
Distribution parameter	2.01	0.20	0.38	1.01	0.20	3.18	0.53
Substitution parameter	-0.12	0.40	2.13	74.77	1.33	-0.18	0.59
Elasticity of substitution	1.14	0.72	0.32	0.01	0.43	1.22	0.63
Adjusted R-Square	0.98	0.97	0.98	0.91	0.97	0.95	0.99
F Stat	364.91	268.36	350.97	85.17	237.16	166.88	784.43
D-W Stat	1.33	1.49	1.90	1.94	1.69	1.60	1.62

	Non-Metallic Mineral	Basic and Non-Ferrous metal	Electrical and Optical Equipment	Transport Equipment	Manufacturing, Nec; Recycling	Manufacturing
β1	-8.09	3.82	-0.42	2.66	3.75	-1.73
t (β1)	-2.10	1.77	-0.25	0.96	0.80	-1.29
β2	1.15	0.88	0.74	0.80	0.34	0.96
t (β2)	4.14	2.80	4.39	2.94	0.94	12.60
β3	0.44	-0.13	0.29	-0.02	0.30	0.14
t (β3)	2.82	-0.36	3.44	-0.06	0.88	2.25
β4	0.00	0.07	-0.01	0.06	0.01	-0.07
t (β4)	-0.09	0.75	-0.41	0.80	0.14	-2.92
α	**0.01**	**0.05**	**0.04**	**0.06**	**0.05**	**0.06**
t(α)	1.18	10.05	6.10	3.45	0.96	10.70
Efficiency parameter	3.1E-04	4.6E+01	6.6E-01	1.4E+01	4.3E+01	1.8E-01
Scale parameter	1.59	0.75	1.03	0.78	0.65	1.10
Distribution parameter	0.28	-0.17	0.28	-0.03	0.47	0.13
Substitution parameter	0.03	0.95	0.13	5.68	-0.18	1.21
Elasticity of substitution	0.97	0.51	0.88	0.15	1.22	0.45
Adjusted R-Square	0.97	0.98	0.99	0.97	0.95	1.00
F Stat	238.45	337.23	718.50	243.57	144.10	2413.05
D-W Stat	1.17	1.44	1.46	1.01	1.43	1.74

Source: Data collected from Annual Survey of Industries (ASI)

Deflator Used: GDP deflator at 2004-05 prices.

Note: Regression is carried out with HAC (Newey-West) estimator.

Table A3.11: CES Production Function for Registered Manufacturing (1995-2011, Single Deflation)

	Food Products	Textile Products	Leather Products	Wood Products	Paper Products	Rubber, Plastic and Petroleum	Chemical Products
β1	7.14	2.67	1.73	-3.49	9.99	16.20	-11.04
t (β1)	4.15	3.98	0.71	-1.90	5.36	1.53	-3.54
β2	0.70	1.04	3.41	0.46	1.80	5.31	-2.38
t (β2)	1.72	3.34	4.90	0.78	2.80	1.16	-1.26
β3	-0.18	-0.23	-2.51	0.83	-1.44	-4.90	3.94
t (β3)	-0.49	-0.79	-3.12	1.17	-2.02	-1.06	2.06
β4	0.38	0.32	3.17	-0.32	0.39	0.84	-0.78
t (β4)	1.94	2.35	4.07	-0.79	1.65	1.06	-1.81
α	**0.02**	**0.02**	**0.02**	**0.01**	**0.05**	**0.08**	**0.03**
t(α)	1.06	10.59	1.44	0.97	5.88	3.25	5.63
Efficiency parameter	1.3E+03	1.4E+01	5.6E+00	3.0E-02	2.2E+04	1.1E+07	1.6E-05
Scale parameter	0.52	0.82	0.90	1.29	0.35	0.41	1.56
Distribution parameter	-0.35	-0.28	-2.80	0.64	-4.07	-11.88	2.52
Substitution parameter	3.09	2.22	0.66	2.18	0.11	0.03	-0.26
Elasticity of substitution	0.24	0.31	0.60	0.31	0.90	0.97	1.35
Adjusted R-Square	0.93	0.98	0.96	0.96	0.91	0.79	0.94
F Stat	50.61	181.51	100.11	94.22	42.27	16.12	62.69
D-W Stat	1.98	2.44	1.52	2.62	2.41	1.27	2.13

	Non-Metallic Mineral	Basic and Non-Ferrous metal	Electrical and Optical Equipment	Transport Equipment	Manufacturing, Nec; Recycling	Manufacturing
β1	3.01	1.04	2.20	5.52	-2.30	-4.39
t (β1)	0.60	0.36	0.56	1.22	-0.33	-1.34
β2	5.30	-0.48	1.27	1.01	0.97	0.09
t (β2)	3.52	-0.35	1.71	1.35	2.34	0.14
β3	-4.22	1.37	-0.36	-0.35	0.29	1.17
t (β3)	-2.47	0.99	-0.38	-0.36	1.03	1.50
β4	1.22	-0.29	0.20	0.07	0.02	-0.37
t (β4)	2.78	-0.86	0.70	0.25	0.18	-1.85
α	**0.05**	**0.05**	**0.05**	**0.09**	**-0.01**	**0.06**
t(α)	3.10	6.09	3.58	3.25	-0.21	7.62
Efficiency parameter	2.0E+01	2.8E+00	9.0E+00	2.5E+02	1.0E-01	1E-02
Scale parameter	1.08	0.89	0.91	0.66	1.26	1.26
Distribution parameter	-3.91	1.54	-0.39	-0.53	0.23	0.93
Substitution parameter	0.12	-0.77	0.81	0.26	-0.14	8.51
Elasticity of substitution	0.89	4.33	0.55	0.79	1.16	0.11
Adjusted R-Square	0.94	0.94	0.95	0.89	0.93	0.99
F Stat	60.51	60.55	77.64	32.94	54.38	325.76
D-W Stat	1.34	1.74	1.26	1.58	1.75	2.38

Source: Data collected from Annual Survey of Industries (ASI)

Deflator Used: GDP deflator at 2004-05 prices.

Note: Regression is carried out with HAC (Newey-West) estimator.

Table A3.12: CES Production Function for Registered Manufacturing (1995-2011, Double Deflation)

	Food Products	Textiles Products	Leather Products	Wood Products	Paper Products	Rubber, Plastic and Petroleum	Chemical Products
β1	20.26	11.45	-0.19	-19.75	10.08	-7.77	-18.37
t (β1)	2.20	3.62	-0.03	-1.07	2.15	-0.41	-2.54
β2	0.82	-1.11	1.84	-1.48	2.59	8.32	-1.45
t (β2)	0.53	-1.22	0.50	-0.61	1.82	0.88	-0.28
β3	-1.17	1.20	-0.86	4.05	-2.22	-5.88	3.58
t (β3)	-0.86	1.29	-0.22	1.20	-1.39	-0.61	0.70
β4	1.44	0.06	1.77	-2.69	0.75	1.11	-0.72
t (β4)	2.64	0.13	0.42	-0.92	1.55	0.66	-0.64
α	**-0.02**	**0.08**	**0.07**	**0.05**	**0.05**	**-0.10**	**0.04**
t(α)	-0.67	7.96	1.76	0.59	2.92	-2.36	3.27
Efficiency parameter	6.3E+08	9.4E+04	8.2E-01	2.7E-09	2.4E+04	4.2E-04	1.1E-08
Scale parameter	-0.35	0.08	0.98	2.57	0.37	2.44	2.13
Distribution parameter	3.33	14.22	-0.88	1.57	-6.06	-2.41	1.68
Substitution parameter	-1.06	0.01	2.20	-2.32	0.10	0.11	-0.59
Elasticity of substitution	-16.78	0.99	0.31	-0.76	0.91	0.90	2.42
Adjusted R-Square	0.87	0.97	0.88	0.63	0.88	0.45	0.93
F Stat	28.56	146.40	30.86	7.86	30.60	4.22	58.30
D-W Stat	2.00	1.38	1.39	1.84	1.39	2.04	1.85

	Non-Metallic Mineral	Basic and Non-Ferrous metal	Electrical and Optical Equipment	Transport Equipment	Manufacturing, Nec; Recycling	Manufacturing
β1	11.75	7.10	-3.38	-1.34	-2.85	-10.17
t (β1)	1.15	3.32	-0.86	-0.19	-0.45	-2.05
β2	4.40	0.63	-0.77	1.09	0.93	1.25
t (β2)	1.34	0.65	-0.78	0.81	1.71	1.04
β3	-4.07	-0.08	1.92	0.02	0.36	0.39
t (β3)	-1.09	-0.08	1.73	0.01	0.83	0.28
β4	1.26	0.14	-0.44	-0.10	-0.01	-0.01
t (β4)	1.33	0.60	-1.29	-0.20	-0.11	-0.02
α	**0.12**	**0.04**	**0.09**	**0.16**	**0.02**	**0.05**
t(α)	3.41	7.11	5.58	5.35	0.34	4.78
Efficiency parameter	1.3E+05	1.2E+03	3.4E-02	2.6E-01	5.8E-02	4E-05
Scale parameter	0.32	0.55	1.15	1.12	1.29	1.65
Distribution parameter	-12.57	-0.15	1.67	0.02	0.28	0.24
Substitution parameter	0.05	3.09	-0.68	8.59	0.10	0.06
Elasticity of substitution	0.96	0.24	3.14	0.10	0.91	0.94
Adjusted R-Square	0.94	0.97	0.97	0.94	0.94	0.99
F Stat	63.91	131.31	141.70	59.17	67.75	365.46
D-W Stat	1.57	2.33	1.45	1.73	2.31	1.95

Source: Data collected from Annual Survey of Industries (ASI)

Deflator Used: GDP deflator at 2004-05 prices.

Note: Regression is carried out with HAC (Newey-West) estimator.

Table A3.13 Translog Production Function for Registered Manufacturing (1980-81 to 2012-13, Single Deflation)

	Food Products	Textile Products	Leather Product	Wood Products	Paper Product	Rubber, Plastic and Petroleum	Chemical Products
β0	-256.70	-119.27	-241.31	-150.90	172.67	1882.61	-92.74
t(β0)	-0.66	-0.44	-0.95	-1.87	1.59	1.54	-0.22
βl	3.58	8.72	49.48	49.75	-19.45	-258.04	23.59
t(βl)	0.05	0.18	1.09	1.53	-0.60	-1.34	0.37
βk	35.77	10.33	-4.09	-22.11	-5.71	-48.80	-7.03
t(βk)	1.01	0.69	-0.25	-1.10	-0.30	-2.06	-0.38
βt	**-3.68**	**-1.40**	**-2.22**	**0.51**	**0.01**	**15.23**	**-0.65**
t(βt)	-1.35	-1.83	-1.02	0.45	0.01	1.62	-0.37
βll	-1.11	0.39	-1.43	-1.18	0.39	4.32	-0.90
t(βll)	-0.70	0.37	-1.27	-0.75	0.40	1.10	-0.63
βkk	-1.79	0.40	-0.21	0.45	0.12	0.04	-0.24
t(βkk)	-1.81	1.74	-1.88	0.70	0.33	0.19	-1.18
βlk	4.37	-2.25	1.23	0.29	-0.02	3.87	1.63
t(βlk)	1.03	-1.62	0.79	0.07	-0.01	1.86	0.78
βlt	**-0.18**	**0.21**	**0.21**	**0.02**	**0.04**	**-1.06**	**0.03**
t(βlt)	-0.54	2.09	1.15	0.13	0.37	-1.49	0.23
βkt	**0.46**	**-0.11**	**-0.01**	**-0.08**	**-0.03**	**-0.18**	**0.02**
t(βkt)	1.64	-1.64	-0.15	-0.60	-0.37	-1.68	0.67
βtt	**-0.02**	**0.00**	**-0.01**	**0.00**	**0.00**	**0.03**	**0.00**
t(βtt)	-1.59	1.25	-1.07	0.60	0.16	1.46	-0.98
Adjusted R-square	0.99	0.97	0.98	0.93	0.97	0.96	0.99
F-statistic	258.81	128.79	155.75	50.20	109.84	82.23	361.26
D-W stat	1.89	1.90	1.99	2.36	1.94	2.18	1.86

	Non-Metallic Mineral	Basic and Non-Ferrous metal	Electrical and Optical Equipment	Transport Equipment	Manf. Nec. and Recycling	Manf.
β0	326.87	-78.44	-173.35	-112.41	-595.91	-130.10
t(β0)	1.71	-0.36	-1.10	-0.61	-1.52	-0.44
βl	-51.00	20.52	35.91	-5.90	110.04	44.14
t(βl)	-1.78	0.69	1.98	-0.34	1.38	1.18
βk	0.09	-9.14	-8.27	23.22	11.80	-26.00
t(βk)	0.01	-0.66	-0.69	1.07	0.54	-1.49
βt	**1.38**	**1.41**	**0.45**	**-1.21**	**-10.22**	**1.47**
t(βt)	1.07	1.28	0.33	-0.55	-1.63	1.01
βll	1.06	-0.85	-1.02	-0.05	-2.47	-0.80
t(βll)	1.80	-1.21	-2.50	-0.11	-1.12	-0.98
βkk	0.02	-0.31	-0.18	-0.65	-0.06	0.33
t(βkk)	0.28	-1.38	-0.59	-2.26	-0.29	1.10
βlk	-0.11	1.98	1.39	0.80	-1.07	0.37
t(βlk)	-0.10	1.13	1.06	0.71	-0.38	0.28
βlt	**-0.10**	**-0.16**	**-0.08**	**-0.13**	**0.87**	**0.06**
t(βlt)	-0.85	-1.65	-0.78	-1.22	1.50	0.77
βkt	**0.00**	**0.06**	**0.04**	**0.23**	**0.18**	**-0.15**
t(βkt)	0.10	1.95	0.42	2.09	1.04	-1.70
βtt	**0.00**	**0.00**	**0.00**	**-0.01**	**-0.05**	**0.01**
t(βtt)	-0.14	-0.16	-0.18	-1.61	-1.76	1.93
Adjusted R-squared	0.98	0.98	0.99	0.98	0.95	1.00
F-statistic	147.40	186.48	441.32	153.66	62.92	1315.91
D-W stat	1.56	2.12	1.34	1.79	1.36	2.13

Source: Data collected from Annual Survey of Industries (ASI)

Deflator Used: GDP deflator at 2004-05 prices.

Note: Regression is carried out with HAC (Newey-West) estimator.

Table A3.14 Translog Production Function for Registered Manufacturing (1995-2009, Single Deflation)

	Food Products	Textile Products	Leather Products	Wood Products	Paper Products	Rubber, Plastic and Petroleum	Chemical Products
β0	-436.38	-138.26	-702.52	-48.97	233.79	1744.12	-816.70
t(β0)	-0.20	-0.73	-2.95	-0.39	1.67	1.48	-0.56
βl	-126.94	32.77	138.35	10.28	-213.96	-321.60	181.51
t(βl)	-0.25	0.77	2.90	0.23	-2.78	-1.73	0.99
βk	206.79	-6.16	-4.63	-2.50	171.56	14.71	-49.47
t(βk)	0.99	-0.32	-0.18	-0.10	2.52	0.52	-0.52
βt	**-20.91**	**-3.33**	**-7.58**	**1.10**	**-8.67**	**18.35**	**-1.05**
t(βt)	-1.97	-3.28	-3.30	0.72	-2.56	2.16	-0.20
βll	4.59	-0.51	-4.31	1.58	5.22	7.74	-6.12
t(βll)	0.35	-0.45	-2.02	0.75	3.15	2.07	-1.27
βkk	-1.03	0.30	-1.03	2.03	-2.25	0.18	-1.16
t(βkk)	-0.41	0.83	-0.61	1.93	-1.72	0.57	-1.26
βlk	-10.51	-0.71	4.45	-7.41	-3.94	-2.26	9.24
t(βlk)	-0.51	-0.32	0.72	-1.34	-2.12	-0.92	1.05
βlt	**1.18**	**0.34**	**0.57**	**0.32**	**0.25**	**-1.70**	**0.16**
t(βlt)	1.14	2.61	2.40	1.09	1.93	-2.58	0.42
βkt	**0.31**	**-0.11**	**0.10**	**-0.47**	**0.37**	**0.12**	**-0.09**
t(βkt)	0.59	-1.62	0.45	-2.03	1.36	0.96	-0.80
βtt	**-0.02**	**0.00**	**-0.01**	**0.02**	**0.00**	**0.04**	**0.01**
t(βtt)	-1.13	0.94	-2.11	1.99	1.27	2.23	0.70
Adjusted R-squared	0.95	0.98	0.98	0.96	0.94	0.94	0.89
F-statistic	35.78	92.69	70.39	48.47	28.29	27.61	16.14
D-W stat	2.23	2.99	2.26	2.29	3.00	2.39	2.46

	Non-Metallic Mineral	Basic and Non-Ferrous metal	Electrical and Optical Equipment	Transport Equipment	Manf. Nec. and Recycling	Manf.
β0	107.74	-172.84	-104.11	53.96	-317.88	-547.43
t(β0)	0.18	-0.61	-0.43	0.11	-0.39	-1.06
βl	21.74	40.42	40.28	-21.39	58.51	73.12
t(βl)	0.16	1.09	1.65	-0.47	0.33	1.13
βk	-35.74	-14.02	-23.06	11.04	4.49	-4.39
t(βk)	-0.91	-0.62	-1.05	0.19	0.19	-0.15
βt	**2.43**	**0.93**	**1.44**	**0.79**	**-4.07**	**1.06**
t(βt)	0.42	0.64	0.76	0.12	-0.28	0.51
βll	-0.46	-1.76	-0.90	0.69	-1.22	-0.65
t(βll)	-0.15	-1.45	-1.84	0.50	-0.25	-0.37
βkk	0.62	-0.65	0.33	-0.05	0.09	0.52
t(βkk)	0.92	-1.44	0.60	-0.04	0.44	0.49
βlk	0.19	3.87	0.51	-0.77	-0.75	-1.83
t(βlk)	0.07	1.14	0.25	-0.28	-0.26	-0.42
βlt	**0.00**	**-0.13**	**0.00**	**-0.11**	**0.39**	**0.08**
t(βlt)	0.00	-1.11	-0.03	-0.47	0.24	0.55
βkt	**-0.19**	**0.05**	**-0.11**	**0.09**	**0.01**	**-0.15**
t(βkt)	-1.24	0.90	-0.78	0.26	0.02	-0.94
βtt	**0.01**	**0.00**	**0.01**	**-0.01**	**-0.01**	**0.01**
t(βtt)	0.55	0.39	0.96	-1.10	-0.18	1.39
Adjusted R-squared	0.94	0.94	0.97	0.85	0.90	0.99
F-statistic	26.64	29.37	64.69	11.09	17.83	144.51
D-W stat	2.02	2.50	1.91	1.70	1.49	2.48

Source: Data collected from Annual Survey of Industries (ASI)

Deflator Used: GDP deflator at 2004-05 prices.

Note: Regression is carried out with HAC (Newey-West) estimator.

Table A3.15 Translog Production Function for Registered Manufacturing (1995-2009, Double Deflation)

	Food Products	Textile Products	Leather Product	Wood Products	Paper Product	Rubber, Plastic and Petroleum	Chemical Products
β0	8725.95	86.35	-28.73	-74.18	329.57	-1159.95	-1212.27
t(β0)	1.55	0.22	-0.02	-0.18	1.05	-0.41	-0.60
βl	-2521.27	39.43	-206.71	-26.27	17.31	27.24	221.62
t(βl)	-1.76	0.45	-0.54	-0.18	0.20	0.06	0.94
βk	1272.15	-47.99	209.19	30.64	-64.10	123.56	-33.47
t(βk)	1.97	-1.45	0.93	0.37	-0.97	1.58	-0.27
βt	**-65.05**	**2.88**	**-3.93**	**8.22**	**4.49**	**-2.91**	**-3.71**
t(βt)	-2.06	0.82	-0.32	1.53	1.62	-0.15	-0.45
βll	73.53	-3.38	11.32	8.40	1.53	1.92	-7.03
t(βll)	1.81	-1.97	0.67	1.13	0.80	0.23	-1.27
βkk	6.49	-1.54	2.11	6.67	2.65	-0.49	-1.57
t(βkk)	1.08	-1.88	0.24	1.84	1.98	-0.47	-1.35
βlk	-115.27	10.08	-26.77	-29.87	-6.59	-7.46	9.91
t(βlk)	-1.79	3.25	-0.65	-1.56	-2.51	-1.41	0.93
βlt	**5.18**	**-0.31**	**-0.64**	**0.53**	**0.43**	**-0.44**	**0.36**
t(βlt)	1.82	-0.84	-0.40	0.53	2.35	-0.29	0.63
βkt	**-0.63**	**0.10**	**0.96**	**-1.24**	**-0.70**	**0.54**	**-0.08**
t(βkt)	-0.58	0.80	0.69	-1.57	-2.29	1.94	-0.54
βtt	**0.00**	**0.00**	**-0.01**	**0.05**	**0.02**	**-0.01**	**0.01**
t(βtt)	0.02	0.52	-0.38	1.38	1.80	-0.21	0.73
Adjusted R-squared	0.91	0.99	0.83	0.86	0.95	0.44	0.92
F-statistic	19.72	184.55	9.85	11.93	36.78	2.42	21.18
D-W stat	2.27	2.75	1.54	1.76	3.43	2.23	2.12

	Non-Metallic Mineral	Basic and Non-Ferrous metal	Electrical and Optical Equipment	Transport Equipment	Manf. nec. and Recycling	Manf.
β0	-412.06	-120.76	-49.31	491.98	6.76	916.15
t(β0)	-0.65	-0.49	-0.26	0.47	0.00	0.72
βl	131.17	40.02	29.45	-80.38	-21.09	-64.09
t(βl)	0.95	1.23	1.73	-0.68	-0.08	-0.41
βk	-54.99	-18.40	-20.95	1.97	17.80	-47.94
t(βk)	-1.30	-1.07	-1.23	0.03	0.55	-1.09
βt	**-5.28**	**0.23**	**2.88**	**4.70**	**2.51**	**5.38**
t(βt)	-0.82	0.19	2.06	0.52	0.10	1.06
βll	-1.77	-1.59	-1.83	1.90	0.88	1.08
t(βll)	-0.62	-1.43	-5.80	0.61	0.13	0.37
βkk	1.55	-0.38	-0.69	0.21	-0.11	0.73
t(βkk)	1.94	-0.89	-1.86	0.13	-0.49	0.43
βlk	-2.84	3.08	4.73	-1.02	-1.19	-0.13
t(βlk)	-1.04	1.06	3.51	-0.25	-0.37	-0.02
βlt	**0.62**	**-0.01**	**-0.23**	**-0.25**	**-0.52**	**-0.12**
t(βlt)	1.21	-0.10	-2.35	-0.86	-0.22	-0.29
βkt	**-0.16**	**-0.01**	**0.01**	**-0.07**	**0.28**	**-0.20**
t(βkt)	-1.07	-0.10	0.12	-0.15	0.72	-0.78
βtt	**-0.02**	**0.00**	**0.00**	**-0.02**	**0.01**	**0.01**
t(βtt)	-0.96	0.57	0.52	-0.81	0.12	0.44
Adjusted R-squared	0.96	0.97	1.00	0.92	0.92	0.99
F-statistic	45.12	50.91	461.20	21.84	21.92	120.94
D-W stat	2.26	2.34	2.92	1.84	2.26	2.42

Source: Data collected from Annual Survey of Industries (ASI)

Deflator Used: GDP deflator at 2004-05 prices.

Note: Regression is carried out with HAC (Newey-West) estimator.

Table A 4.1: Decomposition of GVA growth into Labour Productivity Growth and Employment Growth for Registered Manufacturing (in Percent)

	Food Products	Textile Products	Leather Product	Wood Products	Paper Product	Rubber, Plastic and Petroleum Product	Chemical Products
Growth in Gross Value Added							
1980-81 to 2012-13	6.59	5.60	7.74	4.12	5.36	10.18	8.20
1980-81 to 1989-90	10.35	3.61	11.11	4.48	5.88	16.81	8.85
1990-91 to 2012-13	6.07	5.63	6.66	7.70	5.08	9.24	6.98
1995-96 to 2011-12	5.29	5.05	6.92	9.36	4.97	10.48	5.50
Growth in Labour Productivity							
1980-81 to 2012-13	5.30	4.24	3.16	2.75	4.75	5.58	5.48
1980-81 to 1989-90	12.19	5.20	5.67	6.23	6.47	13.69	6.76
1990-91 to 2012-13	4.74	3.50	1.95	4.35	4.33	4.47	4.41
1995-96 to 2011-12	4.09	3.38	1.79	4.95	5.03	5.80	3.82
Growth in Total Person Engaged							
1980-81 to 2012-13	1.23	1.30	4.44	1.33	0.59	4.35	2.58
1980-81 to 1989-90	-1.63	-1.51	5.15	-1.65	-0.55	2.75	1.95
1990-91 to 2012-13	1.27	2.05	4.62	3.20	0.73	4.57	2.46
1995-96 to 2011-12	1.16	1.61	5.04	4.20	-0.05	4.42	1.63
Residual							
1980-81 to 2012-13	0.07	0.06	0.14	0.04	0.03	0.24	0.14
1980-81 to 1989-90	-0.20	-0.08	0.29	-0.10	-0.04	0.38	0.13
1990-91 to 2012-13	0.06	0.07	0.09	0.14	0.03	0.20	0.11
1995-96 to 2011-12	0.05	0.05	0.09	0.21	0.00	0.26	0.06

	Non-Metallic Mineral Product	Basic & Non-Ferrous metal Product	Electrical & Optical Equipment	Transport Equipment	Manufacturing, Nec, Recycling	Manufacturing
			Growth in Gross Value Added			
1980-81 to 2012-13	9.22	7.15	8.95	8.94	12.68	7.75
1980-81 to 1989-90	10.15	3.94	11.31	4.57	9.06	6.62
1990-91 to 2012-13	9.86	8.07	8.13	10.45	13.05	8.21
1995-96 to 2011-12	12.06	7.42	8.30	9.82	11.71	8.06
			Growth in Labour Productivity			
1980-81 to 2012-13	6.49	5.50	6.57	7.30	4.10	5.80
1980-81 to 1989-90	8.11	3.50	8.02	4.53	6.11	6.74
1990-91 to 2012-13	5.79	5.52	6.13	8.16	3.74	5.68
1995-96 to 2011-12	6.79	4.97	6.35	8.09	2.78	5.67
			Growth in Total Person Engaged			
1980-81 to 2012-13	2.57	1.56	2.23	1.53	8.25	1.85
1980-81 to 1989-90	1.89	0.43	3.04	0.04	2.78	-0.11
1990-91 to 2012-13	3.84	2.42	1.88	2.11	8.97	2.39
1995-96 to 2011-12	4.94	2.33	1.83	1.60	8.69	2.26
			Residual			
1980-81 to 2012-13	0.17	0.09	0.15	0.11	0.34	0.11
1980-81 to 1989-90	0.15	0.01	0.24	0.00	0.17	-0.01
1990-91 to 2012-13	0.22	0.13	0.12	0.17	0.34	0.14
1995-96 to 2011-12	0.34	0.12	0.12	0.13	0.24	0.13

Source: Data Collected and Estimated from Annual Survey of Industries (ASI)

Base Year: 2004-05 prices

Note: The figures are compound growth rates showing the antilogarithms of the relevant regression coefficient minus one when the equations are of the form log Y = a + bT and T refers to time.

Table A 4.2: Growth in Net Capital Stock (1983-84 to 2011-12)

	Agriculture and Allied activities	Mining and Quarrying	Manufacturing	Electricity, gas and water Supply	Construction	Services	Overall
1983-84 to 2011-12	3.64	5.26	7.99	5.03	10.92	6.14	6.28
1983-84 to 1993-94	2.83	8.03	7.25	7.17	4.40	4.26	5.07
1993-94 to 2004-05	3.64	0.94	7.39	3.60	12.53	6.24	5.93
2004-05 to 2011-12	5.91	12.28	10.69	7.38	17.41	9.49	9.70
1993-94 to 2011-12	4.45	5.66	8.45	4.66	15.70	7.48	7.32
1995-96 to 2011-12	4.75	6.41	8.41	4.85	16.77	7.86	7.62

Source: Calculated from National Accounts Statistics

1. NAS, Back Series, Statement 17, p. 154
2. NAS, 2014, Statement 22, p. 55

Base Year: 2004-05 prices

Note: The figures are compound growth rates showing the antilogarithms of the relevant regression coefficient minus one when the equations are of the form log Y = a + bT and T refers to time.

Table A4.3: Employment Elasticity for Registered Manufacturing

Model : $ln(L) = \alpha + \beta \ln NVA$

	β-Coefficients	t-stat
1980-2013	0.22	9.25
1980-1990	0.03	0.55
1991-2013	0.29	7.57
1991-2000	0.24	2.47
2001-2013	0.45	15.32

Source: Author's calculation. Data collected from ASI database.

Deflator: GDP Deflator at 2004-05 prices.

Table A5.1 Labour Productivity Estimates: (in Million Rs. per person engaged)

Year	A+B Agriculture and Allied Activities			C Mining and Quarrying			15+16 Food Products		
	Industry	System	System (import coefficient)	Industry	System	System (import coefficient)	Industry	System	System (import coefficient)
1995	10.68	9.05	8.99	59.61	41.49	38.31	80.30	13.60	12.91
1996	13.23	11.39	11.31	73.49	50.92	47.00	89.30	16.05	15.20
1997	15.40	13.33	13.29	97.10	95.47	92.60	105.94	46.68	44.37
1998	18.95	16.36	16.24	110.03	80.67	74.93	146.75	26.03	24.59
1999	21.43	18.43	18.29	144.32	105.12	97.71	149.17	28.95	27.34
2000	21.13	18.27	18.16	172.79	121.47	112.67	149.38	28.51	27.18
2001	22.78	19.69	19.57	196.47	131.82	122.21	151.10	29.58	28.10
2002	24.72	21.44	21.31	306.33	203.49	188.68	205.57	35.15	33.38
2003	27.19	23.36	23.21	324.49	200.87	185.30	264.05	39.30	37.30
2004	28.68	24.88	24.72	426.73	279.30	255.82	311.55	44.63	41.95
2005	33.74	29.29	29.03	565.65	348.27	303.55	368.91	50.76	46.92
2006	40.73	35.66	35.39	638.20	418.03	374.99	498.23	62.72	58.12
2007	53.03	46.79	46.79	912.92	570.91	570.91	618.26	77.41	77.41
2008	66.10	58.78	58.37	1046.70	671.69	600.43	771.37	96.43	90.23
2009	86.66	76.71	76.27	1266.34	787.38	716.65	1027.65	121.91	113.47
2010	116.78	103.28	102.64	2088.54	1242.64	1115.41	1099.33	149.56	139.43
2011	148.17	131.14	130.30	3125.83	1715.01	1519.92	1199.20	183.97	170.82

	17+18 Textiles Products			19 Leather Products			20 Wood Products		
	Industry	System	System (import coefficient)	Industry	System	System (import coefficient)	Industry	System	System (import coefficient)
1995	112.60	29.25	27.64	212.00	38.84	35.33	53.09	18.52	17.32
1996	123.05	33.55	31.71	242.21	43.66	39.59	54.87	20.51	19.22
1997	144.01	77.87	74.81	302.10	267.55	242.93	76.37	67.67	61.71
1998	150.73	42.57	40.03	365.80	63.85	57.71	120.60	44.65	40.96
1999	174.83	48.27	45.19	557.65	77.71	71.02	77.17	40.01	36.43
2000	171.83	51.87	48.50	476.69	70.43	64.60	64.50	35.75	32.17
2001	143.13	50.00	46.61	390.76	63.03	57.88	51.68	31.73	28.24
2002	141.27	55.10	51.02	283.30	58.05	53.44	43.80	29.35	26.81
2003	144.81	58.09	53.90	305.20	62.04	57.95	46.07	30.42	27.53
2004	158.07	65.29	59.91	346.57	70.20	64.95	42.51	30.41	26.67
2005	172.93	71.55	63.43	409.28	78.43	71.23	49.30	34.89	30.65
2006	209.37	84.63	76.58	456.53	94.54	87.19	71.44	48.64	41.86
2007	205.34	91.52	91.52	573.39	115.11	115.11	109.34	69.65	69.65
2008	212.46	101.33	92.58	528.84	130.89	121.28	116.44	77.58	68.45
2009	245.57	115.18	106.63	623.53	151.71	142.67	150.84	95.67	86.97
2010	295.65	144.57	132.02	537.21	160.52	150.25	155.55	104.08	96.22
2011	323.50	165.97	152.45	517.45	176.20	165.72	183.52	128.64	117.91

	21+22 Paper Product			23+25 Rubber, Plastic and Petroleum Product			24 Chemical Products		
	Industry	System	System (import coefficient)	Industry	System	System (import coefficient)	Industry	System	System (import coefficient)
1995	239.79	50.95	42.36	390.75	38.02	30.32	330.16	47.05	39.63
1996	229.73	54.19	45.04	440.34	46.37	37.02	371.16	54.34	45.67
1997	205.23	181.74	158.48	427.66	247.63	145.02	441.24	211.01	179.35
1998	224.20	62.35	51.88	447.11	61.40	48.50	512.85	76.72	64.43
1999	255.00	77.09	64.42	501.06	95.97	63.70	632.95	99.27	80.64
2000	262.99	84.95	70.56	1032.50	175.32	101.78	719.58	116.40	94.13
2001	277.80	90.19	73.88	1312.75	173.87	111.54	764.38	125.47	101.49
2002	287.59	96.04	79.96	1673.38	227.67	144.81	819.64	147.26	117.81
2003	317.61	98.22	81.70	2146.57	233.83	154.14	903.74	150.38	121.44
2004	350.40	111.99	89.33	3132.99	290.73	189.92	1101.65	179.78	140.19
2005	396.66	127.89	99.89	4794.42	348.89	220.88	1360.32	211.67	153.38
2006	470.21	158.47	124.55	7199.72	485.71	303.89	1676.22	276.01	203.26
2007	547.64	186.48	186.48	9020.11	543.06	543.06	1920.01	328.01	328.01
2008	580.30	209.87	171.17	12239.04	728.73	455.71	2350.68	404.45	294.42
2009	600.67	218.11	187.37	14318.13	600.38	444.56	2426.25	424.60	334.17
2010	696.13	257.97	221.25	16895.87	761.91	573.67	2610.21	492.35	385.91
2011	780.52	307.57	262.47	19379.73	1052.92	772.25	3039.42	611.55	477.35

	26 Non-Metallic Mineral Product			27+28+29 Basic and Non-ferrous Metal Product			30+33 Electrical and Optical Equipment		
	Industry	System	System (import coefficient)	Industry	System	System (import coefficient)	Industry	System	System (import coefficient)
1995	95.61	47.98	41.77	294.57	59.54	49.72	243.71	86.40	73.54
1996	107.38	56.05	49.00	313.44	69.57	58.27	231.23	91.18	78.17
1997	104.89	98.17	89.10	333.87	160.66	141.16	240.10	222.35	200.58
1998	109.08	62.02	54.30	362.17	88.61	72.49	230.88	107.93	92.71
1999	133.61	75.80	65.15	354.18	100.63	83.10	401.52	118.45	95.68
2000	134.19	79.58	69.13	372.77	111.34	91.59	531.24	142.09	114.22
2001	146.70	84.43	74.91	367.96	115.68	94.24	622.08	154.25	122.59
2002	145.38	88.00	78.44	431.55	134.54	110.22	579.37	168.10	135.41
2003	153.98	89.47	81.59	569.57	159.80	129.72	733.49	186.76	150.43
2004	173.45	104.71	93.96	852.31	224.15	174.58	1040.99	231.71	177.86
2005	205.12	122.16	104.96	1041.05	249.08	178.58	1471.45	263.64	185.76
2006	300.81	178.33	153.38	1484.59	345.75	256.64	2099.18	358.96	259.37
2007	405.05	233.55	233.55	1906.39	438.74	438.74	2530.75	435.18	435.18
2008	435.44	253.34	222.26	2375.02	525.50	396.69	3001.41	494.31	369.76
2009	504.10	291.69	261.97	2424.69	542.97	427.64	3261.09	533.87	410.11
2010	501.05	305.89	275.28	3101.21	674.84	520.96	2886.65	586.02	443.95
2011	540.31	345.23	312.25	3621.08	841.74	642.74	2793.58	671.11	512.31

	34+35 Transport Equipment			36+37 Manufacturing, Nec; Recycling			D Manufacturing		
	Industry	System	System (import coefficient)	Industry	System	System (import coefficient)	Industry	System	System (import coefficient)
1995	1127.71	77.64	63.73	115.25	42.62	37.12	158.12	27.50	31.11
1996	1157.84	90.81	74.82	126.44	48.08	41.90	171.51	31.77	35.95
1997	1236.06	489.86	390.36	171.64	142.77	130.87	192.13	2.76	8.43
1998	1220.26	116.00	93.85	213.09	71.69	60.13	219.24	41.79	47.88
1999	1660.46	140.70	113.13	166.55	75.78	63.84	240.06	49.37	57.24
2000	1565.28	159.19	127.31	155.33	77.69	64.71	260.97	55.05	64.15
2001	1533.09	168.00	133.24	169.18	80.72	66.15	263.10	57.61	67.36
2002	1586.13	188.62	149.86	163.35	86.63	68.41	285.43	63.68	74.30
2003	1671.71	195.32	154.26	186.21	97.84	71.77	330.04	68.92	68.92
2004	1774.01	233.13	175.67	237.84	141.56	90.25	407.16	83.44	100.80
2005	1637.18	265.27	183.57	299.72	185.12	103.56	491.43	92.66	118.98
2006	1871.65	330.73	240.92	367.07	205.33	134.85	651.06	124.47	155.96
2007	1922.15	383.32	383.32	453.62	254.08	254.08	771.30	151.46	191.03
2008	2024.11	439.58	323.55	523.18	328.48	192.39	899.94	184.10	231.01
2009	2553.10	511.04	387.70	759.62	442.24	235.45	1018.43	208.37	256.92
2010	3838.09	633.05	454.26	604.72	439.33	221.85	1132.38	253.58	311.73
2011	4997.24	750.83	538.10	559.71	418.24	230.98	1233.97	304.89	374.00

	E Electricity, Gas and Water Supply			F Construction			G Services		
	Industry	System	System (import coefficient)	Industry	System	System (import coefficient)	Industry	System	System (import coefficient)
1995	510.64	87.18	77.10	55.10	26.49	24.01	57.38	39.83	37.77
1996	582.56	99.64	88.16	65.76	32.36	29.42	70.25	48.61	46.00
1997	777.82	403.92	361.48	88.60	67.61	63.44	82.86	48.45	46.81
1998	1172.94	169.44	148.53	110.67	51.84	46.53	102.93	70.61	66.61
1999	1119.42	176.81	153.54	128.50	63.45	56.53	118.84	82.34	77.68
2000	1143.76	192.72	164.08	129.30	67.51	60.26	129.03	89.67	84.74
2001	1152.03	195.69	167.48	129.09	69.33	62.30	141.32	97.71	92.68
2002	1431.92	248.40	209.74	141.86	78.11	70.27	157.47	110.26	104.54
2003	1434.98	247.02	206.46	169.60	86.98	78.42	169.96	118.47	112.37
2004	1483.49	279.58	223.16	249.82	121.41	106.55	198.89	138.72	129.55
2005	1698.14	319.85	231.81	295.14	139.67	117.30	485.42	148.92	122.30
2006	1985.27	391.03	300.82	362.16	180.30	154.61	284.01	196.53	180.66
2007	2175.71	451.66	451.66	450.23	226.71	226.71	337.31	235.22	235.22
2008	2317.74	524.93	395.81	558.70	276.40	240.42	414.01	293.25	270.80
2009	3311.23	667.09	520.86	622.08	307.32	273.06	493.60	347.34	323.20
2010	3402.35	749.60	555.51	735.68	368.49	324.27	600.85	428.59	393.69
2011	3815.94	885.74	662.13	864.86	447.81	393.32	747.90	532.93	490.12

Source: Calculated from Input-Output Transaction table published by WIOD

Deflator Used: GDP Deflator

Base Year: 2004-05 prices

Table A5.2 Ranking of industries on the basis of their employment potential ('000 employment per Rs. million of final demand)

	1995		1996		1997	
	Rank	Number of workers employed per unit of Final Demand	Rank	Number of workers employed per unit of Final Demand	Rank	Number of workers employed per unit of Final Demand
Agriculture & allied activities	1	10.936	1	8.695	1	7.386
Mining & Quarrying	15	0.406	14	0.407	13	0.122
Food Processing	2	5.961	2	5.294	2	1.666
Textile Product	4	1.989	4	1.801	4	0.632
Leather Product	5	1.358	5	1.275	14	0.079
Wood Product	3	3.453	3	3.352	3	0.840
Paper Product	9	0.914	9	0.925	11	0.195
Rubber, Plastic & Petroleum product	6	1.209	6	1.095	8	0.229
Chemical product	7	1.176	7	1.065	10	0.197
Non-metallic mineral product	11	0.606	11	0.621	6	0.387
Basic and Non-ferrous metal product	13	0.456	13	0.437	12	0.150
Electrical machinery	16	0.297	16	0.308	15	0.065
Transport equipment	14	0.429	15	0.403	16	0.056
Recycling & Manufacturing nec	10	0.782	10	0.823	9	0.225
Electricity, gas & water supply	17	0.293	17	0.285	17	0.049
Construction	8	1.135	8	1.044	7	0.360
Services	12	0.561	12	0.524	5	0.607

	1998		1999		2000	
	Rank	Number of workers employed per unit of Final Demand	Rank	Number of workers employed per unit of Final Demand	Rank	Number of workers employed per unit of Final Demand
Agriculture & allied activities	1	6.562	1	5.902	1	6.113
Mining & Quarrying	16	0.279	16	0.205	16	0.180
Food Processing	2	3.609	2	3.293	2	3.370
Textile Product	4	1.600	4	1.420	4	1.306
Leather Product	6	0.966	5	0.906	5	1.070
Wood Product	3	1.740	3	2.068	3	2.430
Paper Product	7	0.915	6	0.769	6	0.734
Rubber, Plastic & Petroleum product	5	0.983	7	0.711	11	0.403
Chemical product	8	0.830	8	0.642	10	0.535
Non-metallic mineral product	10	0.758	11	0.578	9	0.554
Basic and Non-ferrous metal product	13	0.417	13	0.352	13	0.315
Electrical machinery	15	0.298	14	0.327	14	0.266
Transport equipment	14	0.370	15	0.299	15	0.261
Recycling & Manufacturing nec	11	0.663	10	0.627	7	0.649
Electricity, gas & water supply	17	0.200	17	0.186	17	0.173
Construction	9	0.797	9	0.632	8	0.595
Services	12	0.427	12	0.376	12	0.355

	2001		2002		2003	
	Rank	Number of workers employed per unit of Final Demand	Rank	Number of workers employed per unit of Final Demand	Rank	Number of workers employed per unit of Final Demand
Agriculture & allied activities	1	5.021	1	4.266	1	3.969
Mining & Quarrying	16	0.173	17	0.110	17	0.119
Food Processing	2	2.955	3	2.311	3	2.110
Textile Product	4	1.237	5	1.071	4	1.069
Leather Product	5	1.105	4	1.103	5	1.068
Wood Product	3	2.853	2	3.525	2	3.541
Paper Product	6	0.673	7	0.618	7	0.630
Rubber, Plastic & Petroleum product	11	0.339	13	0.249	12	0.242
Chemical product	10	0.449	10	0.366	10	0.371
Non-metallic mineral product	9	0.506	8	0.526	8	0.544
Basic and Non-ferrous metal product	13	0.299	12	0.255	13	0.223
Electrical machinery	14	0.237	14	0.209	15	0.195
Transport equipment	15	0.235	15	0.205	14	0.205
Recycling & Manufacturing nec	7	0.626	6	0.673	6	0.685
Electricity, gas & water supply	17	0.163	16	0.125	16	0.132
Construction	8	0.555	9	0.485	9	0.437
Services	12	0.307	11	0.259	11	0.244

	2004		2005		2006	
	Rank	Number of workers employed per unit of Final Demand	Rank	Number of workers employed per unit of Final Demand	Rank	Number of workers employed per unit of Final Demand
Agriculture & allied activities	2	3.563	1	3.057	1	2.394
Mining & Quarrying	17	0.085	17	0.092	17	0.052
Food Processing	3	1.835	3	1.662	3	1.246
Textile Product	4	0.938	5	0.880	5	0.623
Leather Product	5	0.932	4	0.898	4	0.657
Wood Product	1	4.078	2	3.030	2	1.710
Paper Product	6	0.583	6	0.531	6	0.348
Rubber, Plastic & Petroleum product	12	0.192	15	0.214	13	0.106
Chemical product	10	0.316	11	0.331	10	0.184
Non-metallic mineral product	8	0.513	8	0.447	8	0.223
Basic and Non-ferrous metal product	15	0.167	14	0.226	15	0.098
Electrical machinery	14	0.169	13	0.228	14	0.102
Transport equipment	13	0.183	12	0.237	12	0.112
Recycling & Manufacturing nec	7	0.519	7	0.466	7	0.264
Electricity, gas & water supply	16	0.121	16	0.168	16	0.078
Construction	9	0.329	10	0.333	9	0.192
Services	11	0.207	9	0.409	11	0.138

	2007		2008		2009	
	Rank	Number of workers employed per unit of Final Demand	Rank	Number of workers employed per unit of Final Demand	Rank	Number of workers employed per unit of Final Demand
Agriculture & allied activities	1	1.645	1	1.260	1	0.914
Mining & Quarrying	17	0.035	17	0.028	17	0.022
Food Processing	3	0.910	3	0.688	3	0.518
Textile Product	4	0.540	4	0.471	4	0.399
Leather Product	5	0.487	5	0.392	5	0.319
Wood Product	2	0.969	2	0.848	2	0.602
Paper Product	6	0.255	6	0.210	6	0.182
Rubber, Plastic & Petroleum product	13	0.082	14	0.059	12	0.058
Chemical product	9	0.135	10	0.104	10	0.087
Non-metallic mineral product	8	0.149	8	0.133	8	0.104
Basic and Non-ferrous metal product	15	0.070	15	0.053	15	0.048
Electrical machinery	14	0.075	13	0.060	14	0.052
Transport equipment	12	0.088	12	0.072	13	0.057
Recycling & Manufacturing nec	7	0.191	7	0.165	7	0.132
Electricity, gas & water supply	16	0.061	16	0.050	16	0.037
Construction	10	0.135	9	0.105	9	0.088
Services	11	0.104	11	0.077	11	0.062

Source: Calculated from Input-Output Transaction table for India & Socio economic accounts published by WIOD

Deflator Used: GDP Deflator

Base Year: 2004-05 prices

Table A5.3 Bivariate distribution of Output and Employment:

Year 1995	Employment (%)				
Output (%)	90-100%	30-40%	20-30%	10-20%	0-10%
80-90%	Agriculture & Allied Activities				
70-80%		Services			
60-70%					Basic and Non-ferrous metal, Electricity, Gas and Water Supply
50-60%		Non-metallic mineral product	Mining	Wood product	Electrical machinery, Leather Product, Chemical Product, Textile Product, Paper Product
40-50%					Food processing, Transport equipment
30-40%			Manufacturing nec., and Recycling	Construction	Rubber, Plastic and Petroleum

Year 1996	Employment (%)					
Output (%)	90-100%	40-50%	30-40%	20-30%	10-20%	0-10
80-90%	Agriculture & allied activities					
70-80%			Services			
60-70%					Basic and Non-ferrous metal product	Electricity, Gas & Water Supply
50-60%		Non-metallic mineral product	Mining	Wood product	Textile Product, Paper Product, Electrical and Optical equipment	Leather Product, Chemical Product
40-50%					Food processing, Construction	Transport Equipment
30-40%				Manufacturing nec. and Recycling		Rubber, Plastic & Petroleum product

Year1997	Employment (%)							
Output (%)	90-100%	80-90%	70-80%	60-70%	50-60%	40-50%	30-40%	10-20%
90-100%		Mining	Electrical and Optical Equipment	Wood Product	Leather product			
80-90%	Agriculture & allied activities	Non-metallic mineral product				Construction		Chemical Product, Transport Equipment, Electricity, Gas & Water Supply
70-80%			manufacturing nec. and Recycling			Rubber, Plastic & Petroleum product	Food Product, Textile Product, Basic metal and non-ferrous product, Services	

Year1998	Employment (%)						
Output (%)	90-100%	50-60%	40-50%	30-40%	20-30%	10-20%	0-10
80-90%	Agriculture & allied activities						
70-80%			Services				
60-70%			Mining				Electricity, Gas & Water Supply
50-60%					Wood, paper, electrical machinery	Textile Product, Basic and non-ferrous metal product	Leather Product, Chemical Product
40-50%		Non-metallic mineral product				Food Product, construction	Transport equipment
30-40%					manufacturing nec., and Recycling	Rubber, Plastic and Petroleum Product	

Year1999	Employment (%)						
Output (%)	90-100%	50-60%	40-50%	30-40%	20-30%	10-20%	0-10
80-90%	Agriculture & Allied activities						
70-80%			Services				
60-70%				Mining			Leather Product, Electricity, Gas & Water Supply
50-60%		Non-metallic mineral product	Wood product		Paper product	Textile Product	Chemical Product
40-50%				Manufacturing nec., and Recycling	Basic and non-ferrous metal product, construction	Food Product, Electrical and Optical euipment	Transport equipment
30-40%						Rubber, plastic & petroleum product	

Year2000	Employment (%)						
Output (%)	90-100%	50-60%	40-50%	30-40%	20-30%	10-20%	0-10
80-90%	Agriculture & Allied activities						
70-80%			Services				
60-70%				Mining			Electricity, Gas & water supply
50-60%		Non-metallic mineral product	Wood product		Paper product, Basic and non-ferrous metal product	Textile, electrical machinery	Leather Product, Chemical Product
40-50%			manufacturing nec and Recycling&		Construction	Food Product, Rubber, plastic and petroleum product	Transport Equipment

Year 2001	Employment (%)						
Output (%)	90-100%	50-60%	40-50%	30-40%	20-30%	10-20%	0-10
80-90%	Agriculture & allied activities						
70-80%			Services				
60-70%				Mining			Electricity, gas & water supply
50-60%		Wood product, Non-metallic mineral product			Textile Product, Paper product, Basic and non-ferrous metal product		Leather Product, Chemical Product, Electrical and Optical equipment
40-50%			Manufacturing nec. and Recycling	Construction		Food processing	Rubber plastic & petroleum product, Transport Equipment

Year2002	Employment (%)							
Output (%)	90-100%	60-70%	50-60%	40-50%	30-40%	20-30%	10-20%	0-10
80-90%								
70-80%	Agriculture & allied activities		Wood product	Services	Mining			
60-70%								Electricity, gas & water supply
50-60%					Textile Product	Paper Product, Basic and non-ferrous metal product		Chemical Product
40-50%		Non-metallic mineral product	manufacturing nec and Recycling		Construction		Food Product, Electrical and Optical equipment	Leather Product, Rubber plastic and petroleum product, Transport Equipment

Year2003	Employment (%)							
Output (%)	90-100%	60-70%	50-60%	40-50%	30-40%	20-30%	10-20%	0-10
80-90%	Agriculture & allied activities							
70-80%				Services				
60-70%						Mining		
50-60%		Wood product	manufacturing nec and Recycling		Textile Product	Paper product, Basic and non-ferrous metal product		Leather product, chemical Product, Electricity, gas & water supply
40-50%		Non-meatallic mineral product				Construction	Food product, electrical machinery	Rubber Plastic & petroleum product, Transport equipment

Year2004	Employment (%)							
Output (%)	90-100%	70-80%	60-70%	50-60%	40-50%	20-30%	10-20%	0-10
70-80%	Agriculture & allied activities				Services	Mining		
60-70%							Basic and non-ferrous metal product	
50-60%		Wood product		Recycling & manufacturing nec	Textile Product	Paper product		Leather Product, Chemical Product, Electricity, gas & water supply
40-50%			Non-metallic mineral product			Construction	Food Product	Rubber plastic & petroleum product, Electrical and optical equipment, Transport equipment

Year2005	Employment (%)							
Output (%)	90-100%	60-70%	50-60%	40-50%	30-40%	20-30%	10-20%	0-10
70-80%	Agriculture & allied activities							
60-70%						Mining		
50-60%							Basic and non-ferrous metal product	Chemical Product Services
40-50%		Wood product	Non-metallic mineral product	manufacturing nec and Recycling	Textile Product		Paper product, construction	Food Product, Leather Product, Rubber plastic and petroleum product, Electricity, gas & water supply
30-40%								Eletcrical and Optical equipment, Transport Equipment equipment

Year2006	Employment (%)						
Output (%)	90-100%	50-60%	40-50%	30-40%	20-30%	10-20%	0-10
70-80%	Agriculture & allied activities			Mining, services			
50-60%		Wood product			Paper product	Basic and non-ferrous metal product	Leather Product, Rubber plastic and petroleum product, Chemical Product, Eletcricity, gas &water supply
40-50%		Non-metallic mineral product	Manufacturing nec Recycling &	Textile Product	Construction		Food Product, electrical and Optical Equipment, Transport equipment

Year2007	Employment (%)						
Output (%)	90-100%	50-60%	40-50%	30-40%	20-30%	10-20%	0-10
80-90%	Agriculture & allied activities						
70-80%			Services	Mining			
60-70%						Basic and non-ferrous metal product	
50-60%		Non-meatallic mineral product	Wood product		Paper product		Leather Product, Chemical Product, Electricity, gas & water supply
40-50%		Manufacturing nec and Recycling	Textile Product		Construction	Transport equipment	Food Product processing, Rubber plastic & petroleum product, Electrical and Optical equipment

Year2008	Employment (%)							
Output (%)	90-100%	60-70%	50-60%	40-50%	30-40%	20-30%	10-20%	0-10
80-90%	Agriculture & allied activities							
70-80%				Services	Mining			
60-70%							Basic and non-ferrous metal product	
50-60%			Wood product, recycling& manufacturi ng nec			Paper product	Leather Product	Chemical Product
40-50%		Non-metallic mineral product		Textile Product		Construction	Transport equipment	Food Product, Rubber plastic and petroleum product, electrical and Optical equipmen, Electricity, gas and water supply

Year2009	Employment (%)							
Output (%)	90-100%	60-70%	50-60%	40-50%	30-40%	20-30%	10-20%	0-10%
80-90%	Agriculture & Allied activities							
70-80%				Services	Mining			
60-70%								
50-60%			Wood product, Manufacturing nec and recycling			Paper product	Leather Product, Basic and non-ferrous metal product	Chemical Product, Electricity, gas & water supply
40-50%		Non-metallic mineral product	Textile Product			Construction	Transport equipment	Food product, Rubber plastic & petroleum product, Electrical and Optical equipment

Source: Constructed from the calculation of ratios in section 5.3 in the chapter. The ratios are calculated from Input-Output Transaction table for India and Socio-economic accounts published by WIOD

Deflator Used: GDP Deflator at 2004-05 prices and CPI (IW & AL) at 2001 prices

Table A 5.4 Linkage Index

Backward Linkage Index									
	Agriculture & Allied activities	Mining	Food products	Textile Product	Leather Product	Wood product	Paper product	Rubber plastic & petroleum product	Chemical Product
1995	0.623	0.814	1.097	0.966	1.032	0.980	1.101	1.314	1.081
1996	0.603	0.801	1.105	0.970	1.064	0.994	1.130	1.287	1.096
1997	1.007	0.823	1.094	1.055	0.827	0.853	0.899	1.103	1.020
1998	0.599	0.723	1.040	1.032	1.064	0.859	1.221	1.336	1.102
1999	0.622	0.699	1.062	1.068	1.018	0.834	1.125	1.277	1.105
2000	0.633	0.712	1.111	1.072	1.033	0.879	1.096	1.091	1.109
2001	0.625	0.717	1.115	1.081	1.046	0.885	1.082	1.090	1.114
2002	0.634	0.652	1.124	1.088	1.084	0.886	1.091	1.074	1.119
2003	0.628	0.690	1.096	1.061	1.030	0.880	1.108	1.059	1.126
2004	0.628	0.638	1.091	1.078	1.031	0.895	1.130	1.038	1.142
2005	0.571	0.595	1.070	1.109	1.027	0.866	1.091	0.974	1.136
2006	0.610	0.634	1.091	1.155	1.032	0.877	1.121	0.971	1.153
2007	0.591	0.626	1.102	1.168	1.055	0.863	1.125	1.003	1.152
2008	0.577	0.616	1.090	1.198	1.051	0.853	1.129	0.968	1.163
2009	0.565	0.610	1.070	1.206	1.065	0.841	1.139	1.048	1.135
2010	0.552	0.568	1.074	1.173	1.097	0.850	1.135	1.015	1.128
2011	0.552	0.567	1.083	1.165	1.120	0.848	1.141	0.985	1.117

	Non-metallic mineral product	Basic and non-ferrous metal product	Electrical machinery	Transport equipment	Manufacturing nec and Recycling &	Electricity gas & water supply	Construction	Services
1995	0.876	1.180	0.853	1.131	1.219	0.905	1.134	0.693
1996	0.868	1.162	0.867	1.119	1.232	0.917	1.091	0.693
1997	0.908	1.209	0.870	0.977	0.968	0.918	1.084	1.384
1998	0.947	1.209	0.874	1.161	1.234	0.874	1.030	0.694
1999	0.965	1.184	1.091	1.162	1.161	0.920	1.013	0.695
2000	0.976	1.194	1.090	1.164	1.163	0.947	1.026	0.703
2001	0.964	1.193	1.086	1.157	1.177	0.957	1.024	0.688
2002	0.992	1.194	1.069	1.172	1.169	0.939	1.023	0.687
2003	1.004	1.167	1.075	1.208	1.190	0.960	1.039	0.678
2004	1.008	1.124	1.105	1.221	1.181	1.010	0.994	0.686
2005	1.002	1.138	1.115	1.154	1.180	1.005	0.979	0.987
2006	0.989	1.145	1.122	1.188	1.172	1.060	0.990	0.689
2007	0.961	1.135	1.126	1.203	1.159	1.071	0.978	0.682
2008	0.978	1.120	1.134	1.211	1.200	1.081	0.960	0.671
2009	0.957	1.142	1.132	1.180	1.268	1.023	0.954	0.665
2010	0.972	1.127	1.160	1.202	1.294	1.055	0.941	0.657
2011	0.977	1.121	1.168	1.223	1.286	1.061	0.933	0.652

Forward Linkage Index									
	Agriculture & Allied activities	Mining	Food products	Textile Products	Leather Products	Wood products	Paper products	Rubber plastic & petroleum product	Chemical Product
1995	1.306	0.814	0.537	0.857	0.611	0.687	0.826	0.772	1.190
1996	1.351	0.822	0.536	0.821	0.609	0.683	0.800	0.791	1.208
1997	1.177	1.025	0.836	0.921	0.787	0.840	0.883	0.940	1.087
1998	1.275	0.865	0.547	0.736	0.611	0.815	0.750	0.726	1.184
1999	1.278	1.127	0.565	0.701	0.637	0.693	0.749	0.776	1.243
2000	1.231	1.198	0.568	0.675	0.608	0.657	0.740	0.970	1.226
2001	1.254	1.087	0.563	0.643	0.581	0.611	0.749	1.023	1.260
2002	1.201	1.234	0.596	0.630	0.545	0.570	0.737	1.060	1.259
2003	1.250	1.101	0.625	0.629	0.554	0.545	0.744	1.085	1.198
2004	1.203	1.171	0.621	0.633	0.568	0.520	0.741	1.130	1.169
2005	1.237	1.320	0.558	0.597	0.513	0.460	0.636	1.090	1.234
2006	1.224	1.186	0.616	0.638	0.585	0.515	0.725	1.301	1.192
2007	1.247	1.202	0.614	0.620	0.605	0.523	0.721	1.266	1.182
2008	1.200	1.173	0.596	0.599	0.569	0.515	0.691	1.265	1.204
2009	1.275	1.081	0.611	0.614	0.585	0.521	0.666	1.187	1.080
2010	1.294	1.095	0.585	0.612	0.559	0.503	0.654	1.176	0.964
2011	1.282	1.163	0.576	0.606	0.554	0.498	0.647	1.168	0.961

	Non-metallic mineral product	Basic and non-ferrous metal product	Electrical machinery	Transport equipment	manufacturing nec and Recycling	Electricity gas & water supply	Construction	Services
1995	0.659	1.911	0.577	0.718	0.597	1.342	0.527	3.069
1996	0.658	1.881	0.571	0.696	0.594	1.282	0.538	3.157
1997	0.862	1.290	0.842	0.888	0.881	1.016	0.845	1.881
1998	0.575	1.745	0.559	0.656	0.640	1.470	0.586	3.259
1999	0.618	1.572	0.660	0.703	0.603	1.276	0.613	3.187
2000	0.623	1.550	0.718	0.712	0.619	1.209	0.658	3.038
2001	0.639	1.493	0.725	0.709	0.662	1.174	0.668	3.159
2002	0.632	1.433	0.693	0.719	0.675	1.223	0.675	3.117
2003	0.615	1.472	0.696	0.719	0.750	1.149	0.672	3.195
2004	0.593	1.556	0.686	0.679	0.819	1.037	0.729	3.144
2005	0.580	1.874	0.647	0.534	0.800	1.038	0.645	3.236
2006	0.622	1.600	0.674	0.598	0.697	0.963	0.705	3.160
2007	0.627	1.686	0.663	0.572	0.697	0.920	0.708	3.145
2008	0.599	1.718	0.656	0.570	0.858	0.862	0.750	3.174
2009	0.594	1.600	0.632	0.582	0.976	0.954	0.747	3.295
2010	0.569	1.655	0.635	0.589	1.143	0.879	0.768	3.322
2011	0.562	1.687	0.612	0.573	1.001	0.869	0.756	3.484

Source: Calculated from Input-Output Transaction table for India published by WIOD

Deflator Used: GDP Deflator

Base Year: 2004-05 prices

ASPECTS OF GROWTH AND PRODUCTIVITY: INDIAN ECONOMY, 1995-2011

by D.p Priydarshi Joshi

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Using an Aggregate Production Function

Some Methodological Issues

D P PRIYADARSHI JOSHI, ALEX M THOMAS

Pranjul Bhandari's use of the Cobb-Douglas production function in "Decoding the Growth Target" (EPW, 16 March 2013) suffers from two sets of interrelated methodological problems. The first one is at the theoretical level and the second one is empirical in nature.

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D P Priyadarshi Joshi (*joshi.eco9988@gmail.com*) is a PhD candidate at the School of Economics, University of Hyderabad and Alex M Thomas (*alexmthomas@gmail.com*) is a PhD candidate at the School of Economics, University of Sydney, Australia.

The use of the aggregate production function attracted severe criticisms in the 1960s (for a detailed account, see Harcourt 1972). Joan Robinson (1953-54) started the debate on capital theory which concluded with Samuelson (1966) admitting to the charge against the universal validity of aggregate productions functions outside a one-commodity model. Capital theory in general and the uncritical employment of the Cobb-Douglas production function were discussed at the 47th annual conference of the Indian Economic Association held at Baroda in December 1964 (see Hazari 1965: 69). Most of the concerns raised seem to have fallen into oblivion (cf Cohen and Harcourt 2003). In this response, we only focus on Bhandari's use of the aggregate production function and we do not appraise her policy suggestions which merit a separate discussion. This note is divided into three sections and a conclusion. Section 1 presents a quick summary of Bhandari's use of the aggregate Cobb-Douglas production function. Section 2 highlights the methodological issues raised by capital theory for aggregate production functions. In Section 3, we critically evaluate the author's calibration of the aggregate production function so as to fit India's growth path.

1 Use of Cobb-Douglas Function

Bhandari employs the Cobb-Douglas production function in order to account for the sources of India's growth. The inputs into production are labour employment adjusted for quality and the stock of fixed capital. These inputs are assumed to operate "at the economy's overall level of productivity" which is measured as a residual (Bhandari 2013: 66). This residual is total factor productivity (TFP). As Bhandari rightly notes, TFP includes "[a]nything that is not associated with the two inputs of production" (ibid). This "black box" can contain diverse factors which are often non-quantifiable – policy environment and institutional arrangements in the economy are two such factors. Bhandari identifies other factors such as transaction costs and extent of financial intermediation. The author considers TFP to be "pure technological progress" (ibid).

Furthermore, Bhandari, in the spirit of the Cobb-Douglas production function assumes perfectly competitive markets where "factor earnings are proportionate to the respective factor productivities" (ibid). That is, she assumes that the marginal productivity theory of distribution operates in the Indian economy. Drawing on Gollin (2002) who highlights the need to take into account the earnings of the self-employed as labour income, Bhandari assumes factor shares to be 0.33 for capital and 0.67 for labour. Subsequently, she outlines three kinds of growth paths (pp 67-69) and suggests that a balanced path is the best approach to undertake. In the next two sections, we put forward our disagreements and concerns about the use of the aggregate Cobb-Douglas production function in growth accounting and in general.

2 Issues with Production Function

The capital theory debates, popularly known as the Cambridge capital controversies, raised the problems associated with measuring capital. Being a heterogeneous factor, capital can only be measured by multiplying its quantities with its prices. Labour, on the other hand, has a natural unit of measurement – such as man days and can be measured independently of its price. That is, the natural unit of measuring labour is time. Hence, in the production function of the form Y = f(K,L) where Y is aggregate output, K is aggregate capital and L is aggregate labour, L can take a value of 100 man days but K can take a value only in monetary terms (Rs 1,000 or some other monetary value). For, to arrive at aggregate capital, the stock of tools, machinery, computer equipment, etc, have to be multiplied by their respective prices. The aggregate production function has been employed in neoclassical economics to explain both income distribution as well as economic growth. When trying to explain income distribution, the theory runs into circular reasoning because income distribution is used to explain prices and to determine prices one requires income distribution since capital has no natural unit of measurement. This lessens its reliability in applied work because logical inconsistency of a model implies that mutually contradictory explanations can be provided. Moreover, there are serious issues relating to aggregation when constructing an aggregate production function (Felipe and Fisher 2003).

In strict terms, it is perhaps impossible to separate the effects on productivity into a labour one and a capital one because the contributions made by improved machinery and better skilled workers are neither additive nor separable. But, as Bhandari maintains, TFP is "pure technological progress" disembodied from the labour and capital equipment. This conception cannot incorporate any sort of dynamic substitution involving a change in the aggregate production function which modifies K and L. Improvements in the policy environment and better institutional arrangements are treated as technological progress disembodied from labour and capital. Even keeping this issue aside, the extremely vague nature of TFP does not seem to add much to our understanding of economic growth. After all, by virtue of being a residual, the higher the number of inputs into production, the less the TFP is. Hence, the TFP estimates can change wildly with changes in the specification of the aggregate production function. For a detailed account of capital theoretic issues especially in the context of Indian manufacturing, see Joshi (2012: 1-5).

3 Critique of Bhandari's Approach

In this section, we identify the problems with the manner in which Bhandari (2013) has calibrated the Cobb-Douglas production function to the Indian economy Bhandari characterises the Indian economy as operating under constant returns to scale, since the sum of the factor shares of labour and capital equals one. Perhaps, this is admissible for a cross-country comparison. But, in an attempt to identify factors of growth, such an assumption is grossly inadequate. This is especially so given the starkly different conditions under which agriculture, manufacturing and services operate in India and their respective productive potential. To have an understanding of growth, the structure of the economy ought to be made transparent.

Second, the assumption of perfect competition in product and factor markets cannot be sustained as it is incongruent with Indian realities. While agriculture in India is largely unorganised (and relatively more competitive), manufacturing and services are mainly oligopolistic. And, the underlying idea that workers are paid according to their marginal products is difficult to uphold. Such an assumption denies the presence of distributional conflicts over income distribution, a facet of India as well as other economies.

The third and final point relates to the author's assumption regarding factor shares: 0.33 for capital and 0.67 for labour. Gollin (2002) is cited in support of using factor income shares which are assumed to be similar across a broad range of countries. However, Gollin (2002: 471) computes the mean labour shares across countries based on data published by United Nations in 1994 and International Labour Organisation in 1993. To use the same set of values today, we think, is not empirically satisfactory. Given the outdated nature of the labour shares and due to the lack of further explanation, it is not clear how credible the factor shares in Bhandari (2013) are.

4 Conclusions

Employing the aggregate production function to "decode" potential growth paths for India is subject to considerable theoretical and empirical difficulties. It would be very beneficial if contemporary growth accounts revisited the capital theory debates of 1960s. Logical inconsistency is indeed a serious scientific charge against the marginalist theory of value and distribution. Therefore, employing marginalist "tools" such as the aggregate Cobb-Douglas production function is also susceptible to logical errors. Unfortunately, some of these difficulties have no solution within the neoclassical (more accurately, marginalist) paradigm. We think that the growth theories based on the economics of Smith, Marx and Keynes are a good alternative.

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D P Priyadarshi Joshi <dppj@uohyd.ac.in>

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