



**THE FIFTH NATIONAL SEMINAR  
ON  
INDUSTRIAL STATISTICS**

**SEMINAR PAPERS**

**29-30 OCTOBER 2014  
FLOATEL, KOLKATA**

*Organised by*  
**Central Statistics Office  
Industrial Statistics Wing  
Government of India  
Kolkata-700 001**

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# Multi-factor Productivity in India's Organised Manufacturing Sector

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## Abstract

*In this paper, we mainly present indicators of single factor productivity and describe a very simple approach to construct a multi-factor productivity index. Construction of labour productivity, capital productivity and multifactor productivity are based on the relation of different output and input components at the national and industry division levels. Annual Survey of Industries (ASI) data during 1990-91 to 2010-11 are used in this paper. Parameters such as Gross Value Added (GVA), number of employees, compensation to employees, man-days worked, fixed capital, gross output are used to understand the productivity in organized manufacturing sector. Based on these parameters labour productivity index, capital productivity index, capital intensity index and multi-factor productivity index are constructed as per the recommendations of the UNIDO. For the construction of index, ASI 2004-05 data has been taken as base period. From the analysis it is found that labour productivity has increased during the period. However, the capital productivity has declined during the study period. Overall the multifactor productivity index has upward trend which implies the overall productivity has increased in the organised manufacturing sector in India.*

## Introduction

Performance indicators primarily measure the economic efficiency of industrial production with respect to the growth of output in relative terms of input. For the business community, performance indicators provide information needed to assess the current economic situation and to indicate the prospective direction in comparison with international economic trends. Performance indicators also help to assess correctly the economic situation of a country as a basis for designing and implementing an effective fiscal or monetary policy. An arbitrary decision or tardy diagnosis of business trends may result in unsound decisions with serious economic consequences.

## Productivity

Productivity is an important measurement of the efficiency of production derived from the ratio of the real output to input over a period of time. A precise measurement of productivity is not so straightforward, especially due to the complexity of input components. In economic statistics, inputs are disaggregated into two major groups, namely primary inputs (also known as factors of production) comprising labour input and

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capital input; and intermediate inputs (materials and supplies, energy, industrial services, etc.). The change in productivity occurs as a result of the change in the efficiency of the use of all these inputs. A modest estimation of the combined effect of a change in primary inputs on output is obtained from econometric models of total factor productivity. In this paper, we mainly present indicators of single factor productivity and describe a very simple approach to constructing a multifactor productivity index. Construction of these indicators is based on the relation of different output and input components at the national, and industrial sector.

### **Objectives of the Study**

1. To examine the productivity in organized manufacturing sector in India
2. To workout on labour productivity, capital productivity and multi-factor productivity index in organized manufacturing sector in India
3. To study the productivity by considering industry divisions in organized manufacturing sector in India

### **Data and Methodology**

Annual Survey of Industries (ASI) data are available for the organized manufacturing sector and those industries are registered under the Factories Act. 1948 are covered in the survey. The ASI data are also available for a long period of time. ASI data since 1990-91 to 2010-11 are used for studying the productivity in organized manufacturing sector in India.

### **Methodology**

In terms of the computation method, IRIS 2008 has broadly defined three types of performance indicators, namely; (a) growth rates, (b) ratio indicators, and (c) share indicators. Construction of such indicators can be based on a wide range of variables for different analytical purposes. Parameters such as Gross Value Added (GVA), number of employees, compensation to employees, man-days worked, fixed capital, gross output have been used to understand the productivity in organized manufacturing sector. Based on these parameters labour productivity index, capital productivity index and multi-factor productivity index are constructed as per the recommendations of the UNIDO.

### **Measuring Productivity in Industrial Sector**

#### **Valued added per employee**

Value added per employee is a more concrete measure of the relation of output to labour input. It indicates the average amount of value added produced by an employee. This is the simplest approximation of the rate of labour productivity in manufacturing sector:

$$\text{Value Added per employee} = \frac{\text{Value\_added}}{\text{Number\_of\_employees}}$$

### **Valued added man-days worked**

Among the indicators based on labour input, value added per hour worked provides the most precise estimate of labour productivity. But data on hours worked is not available, in alternate man-days worked data are used for the analysis. This ratio is obtained by relating the amount of value added for a reference period to the total number of man-days worked during the same period:

$$\text{Value added per man-days worked} = \frac{\text{Value\_Added}}{\text{Number\_of\_Mandays\_Worked}}$$

### **Value added per unit of capital**

Capital here refers to the gross value of fixed assets at the end of the reference period. The value added per unit of capital is calculated as:

$$\text{Value added per unit of capital} = \frac{\text{Value\_Added}}{\text{Gross\_Fixed\_Assets}}$$

This ratio measures the productivity of capital in the reference period.

### **Capital per employee**

This indicator measures the relation of the factors of production, which is calculated as the ratio of the value of gross fixed assets to the number of employees:

$$\text{Capital per employee} = \frac{\text{Gross\_Fixed\_Assets}}{\text{Number\_of\_Employees}}$$

In comparison across sectors and sub-sectors, the capital per employee indicates the factor intensity – the relative importance of one versus the other.

## **Results and Discussion**

Productivity indicators measure the effectiveness and efficiency of a given input in the generation of output. Labour productivity and capital productivity are examples of productivity indicators.

## Labour Productivity

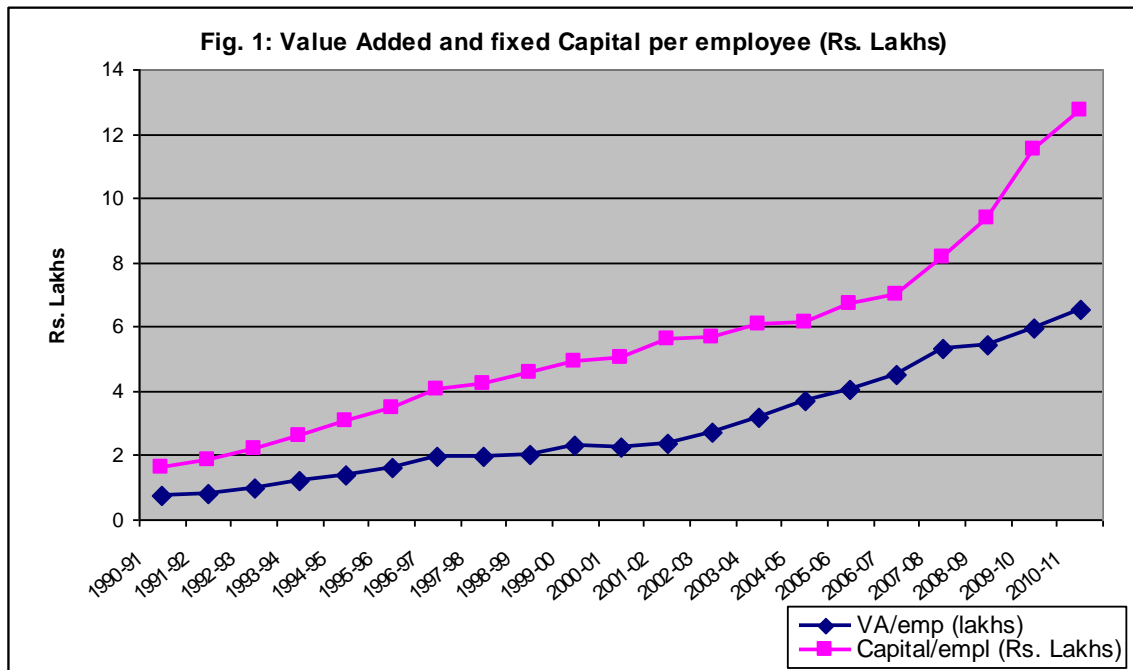
Labour productivity is a revealing indicator of several economic indicators as it offers a dynamic measure of economic growth, competitiveness, and living standards within an economy. It is the measure of labour productivity which helps explain the principal economic foundations that are necessary for both economic growth and social development. It reflects the effectiveness and efficiency of labour in the production and sale of the output. For measuring labour productivity in organized manufacturing sector in India value added per employee and value added per man-days worked is used. Table 1 presents the productivity ratio's based on above measurements during 1990-91 to 2010-11. From the table it is observed that value added per employee has drastically increased during the period. In 1990-91 the value addition per employee has 0.75 lakhs rupees and over the period it has continuously increased. In 2010-11 the value addition per employee has 6.54 lakhs rupees. From figure 1 it is clearly indicating the sharp rise of employees' contribution in the value addition. Similarly if we look into the value addition per man-days worked, it has found that during the period since 1990-91 to 2010-11 there has a sharp increased trend is observed. In 1990-91 the value addition per man-days worked has Rs. 242, whereas in 2010-11 it has increased to Rs. 2124.

**Table-1: Productivity Ratio's in Organised Manufacturing Sector in India: 1990-91 to 2010-11**

Year	VA/Employee (Rs. lakhs)	VA/Mandays- worked (Rs)	VA/Capital	Capital/Employee (Rs. Lakhs)	VA/output
1990-91	0.75	242	0.46	1.64	0.23
1991-92	0.81	259	0.44	1.85	0.22
1992-93	0.98	316	0.44	2.22	0.23
1993-94	1.20	385	0.47	2.58	0.25
1994-95	1.40	446	0.46	3.05	0.25
1995-96	1.62	510	0.47	3.47	0.24
1996-97	1.96	609	0.49	4.02	0.25
1997-98	1.98	N.A	0.47	4.23	0.24
1998-99	2.02	N.A	0.44	4.55	0.22
1999-00	2.31	760	0.47	4.92	0.21
2000-01	2.25	739	0.45	5.05	0.19
2001-02	2.38	785	0.42	5.62	0.19
2002-03	2.72	894	0.48	5.65	0.19
2003-04	3.18	1046	0.52	6.07	0.19
2004-05	3.69	1217	0.60	6.12	0.19
2005-06	4.03	1331	0.60	6.72	0.19
2006-07	4.49	1517	0.64	6.98	0.19
2007-08	5.33	1758	0.65	8.14	0.20
2008-09	5.43	1805	0.58	9.38	0.19
2009-10	5.95	1950	0.52	11.53	0.19
2010-11	6.54	2124	0.51	12.74	0.18

## Capital Productivity

Capital productivity measures the effectiveness and efficiency of capital in the generation of output. It is defined as value added per capital or value added per employee. Capital productivity results from improvements in the machinery and equipment used, as well as the skills of the labour using the capital, processes, etc. For measuring capital productivity, value added per unit of capital and capital per employee is used. From table-1 it is observed that value added per unit of capital is increasing during 1990-91 to 2007-08. From 2008-09 to 2010-11 there is a downward trend is observed. However, capital per employee is sharply increased during the period. In 1990-91 the capital per employee was Rs. 1.64 lakhs and it increased to Rs. 12.74 lakhs in 2010-11. Figure 1 clearly indicates the sharp rise of capital per employee during the period.



The above analysis presents the single factor productivity in GVA and output. This type of measurement is the partial measures of productivity. In the production process the output and value addition is the combined effect of multiple factors of production. In following paragraphs will discuss by considering major factors of production, namely, labour and capital in the form of constructing indices. The construction of index of labour productivity, index of capital productivity and multi-factor productivity are discussed below.



## Labour Productivity Index

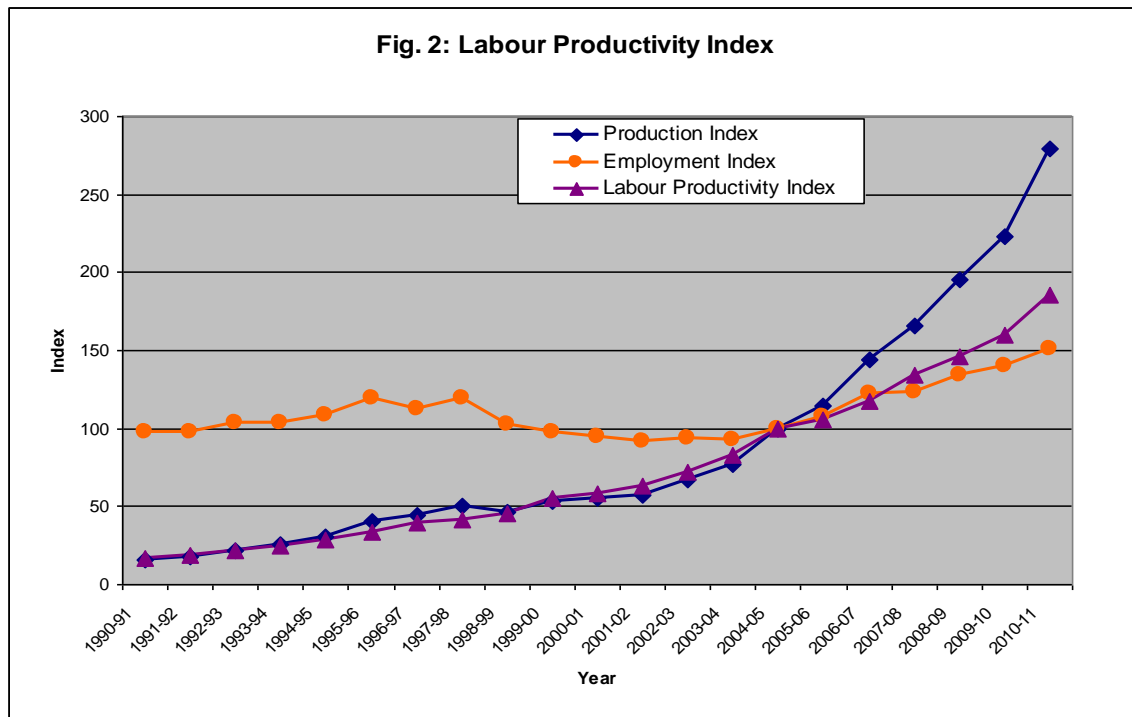
The growth of value added over time depends on the change in the quantity and value of goods and services produced. For a measure of the real change in productivity, it is convenient to calculate the index of labour productivity as a ratio of the production index, which shows the growth in the volume of production to the index of the number of employees:

$$\text{Index of labour productivity} = I_{LP} = \frac{I_Q}{I_L} * 100$$

where

$I_Q$  and  $I_L$  = index of industrial production and the number of employees respectively for given period

Table 2 presents the production index, employment index and labour productivity index during 1990-91 to 2010-11. 2004-05 is used as base period for the construction of the indices. From the table it is observed that both production and employment indices are in upward trend during the period. Labour productivity index is also in upward trend. Figure 2 clearly presents all these indices which is showing an upward trend. The increasing labour productivity index implies the efficiency and effectiveness of labour in the production process. In other words it can be said that contribution of labour in the production process in organised manufacturing sector is increased during the period, which implies labours are properly utilized.



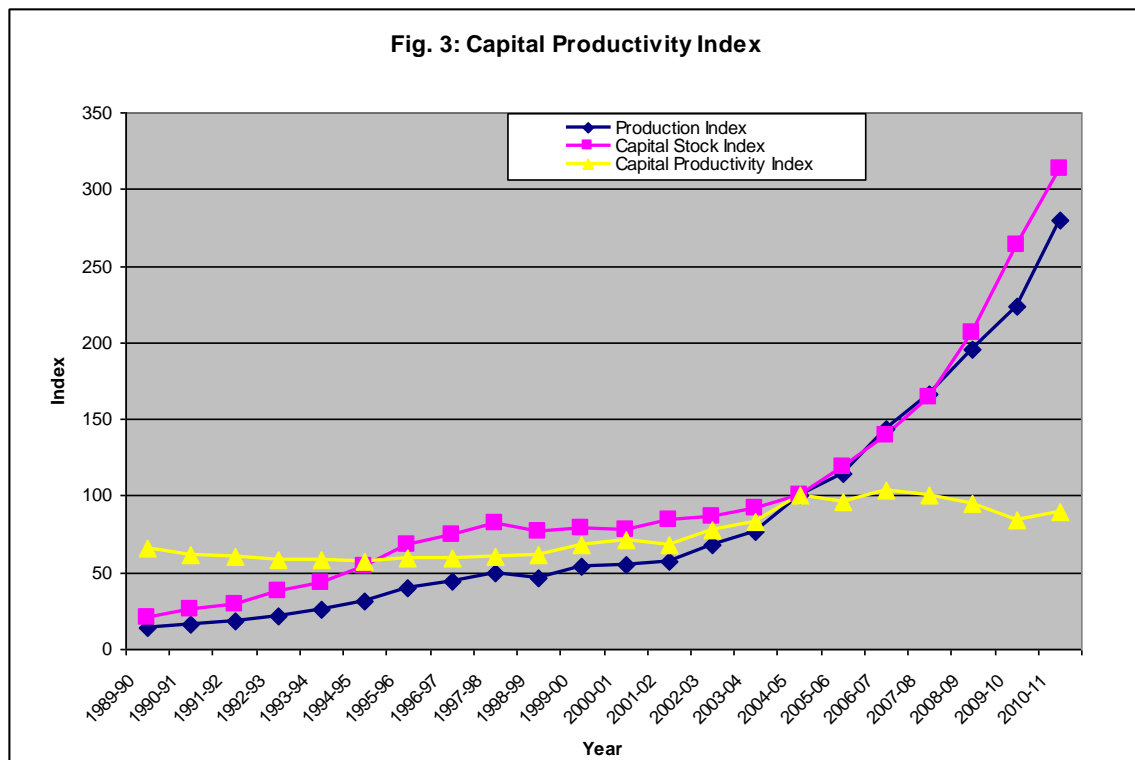
## Index of Capital Productivity

Value added per unit of capital is a single factor productivity measures for capital productivity. But more preferred measure of capital productivity is construction of index. For a measure of the real change in productivity, it is convenient to calculate the index of capital productivity as a ratio of the production index to the index of the value of gross fixed assets.

$$\text{Index of capital productivity} = I_{KP} = \frac{I_Q}{I_K} * 100$$

where:  $I_Q$  and  $I_K$  = index of industrial production and index of the value of gross fixed assets respectively for given period

Table 3 presents the capital productivity index during 1990-91 to 2010-11 with base 2004-05. From the table it is observed that capital stock index is in upward trend. But there is no clear trend in capital productivity index. From the figure 3 it is clearly shown that both production index and capital stock index is in up ward trend, and after 2004-05 there is steep increase in the production. But the capital productivity index shows somewhat mixed results. From this analysis it may be interpreted that capitals are not optimally utilized in the production process.



## Capital Intensity Index

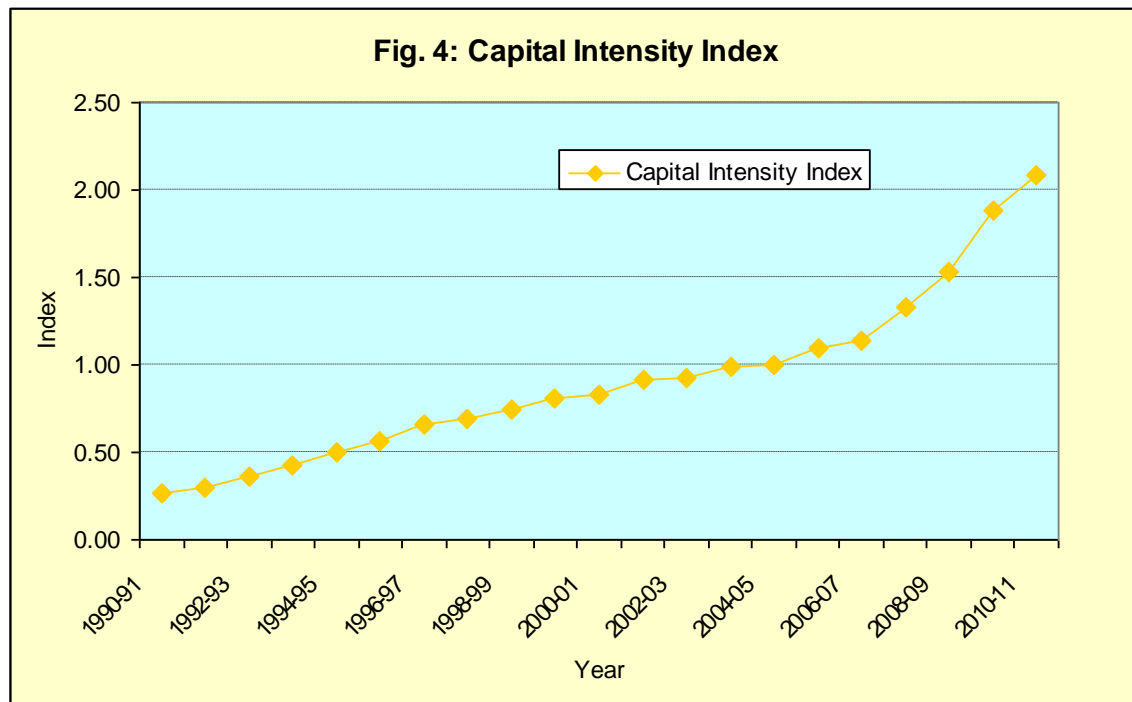
The relation of the factors of production changes over time and this can be measured by the capital intensity index computed as the ratio of two indices related to capital and labour.

$$\text{Capital intensity index} = I_{\text{INT}} = \frac{I_K}{I_L}$$

Where  $I_L$  and  $I_K$  are index of labour productivity and capital productivity respectively.

This index shows the direction of the shift of one or another industry in terms of factor intensity. An increasing value in this index over time shows that an industry is becoming capital intensive.

Table 4 presents the capital intensity index during 1990-91 to 2010-11. From the table it is clearly shown that the capital intensity index was 0.27 in 1990-91 but it increased to 2.08 in 2010-11. There is a sharp rise (fig. 4) in the capital intensity index which implies that the during the period industries are becoming capital intensive.



Labour productivity index only partially reflects the productivity of labour in terms of the personal capacities of workers or the intensity of their effort. The ratio between output and labour input depends to a large degree on the presence of other inputs, such as technology, capital and management etc. Similarly capital productivity index only

measures the production index with respect to capital as input. Therefore, MFP measures are required to capture the influence of all the inputs taken together in the production process.

### **Multi-factor Productivity Index**

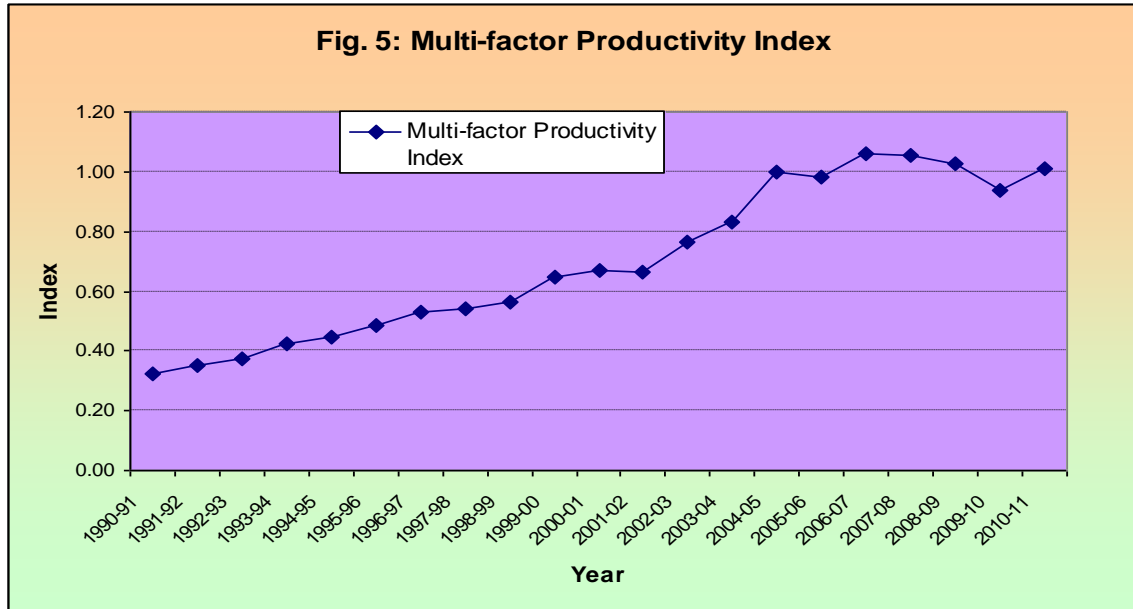
The limitation of partial productivity measures such as labour and capital productivity indices is that they attribute to one factor of production, changes in efficiency that are attributable to other factors including qualitative factors such as better management, improved quality of inputs through training and technology as well as higher quality products and economies of scale. A measure of growth in efficiency which takes account of changes in the most important factors; labour and capital is given by the MFP growth. MFP is calculated as the ratio of output to a weighted combination of labour and capital inputs.

This index refers to the ratio of the production index to the total of labour and capital indices adjusted by their proportional contribution to value added. The formula of the multifactor productivity  $I_{MF}$  index is given by:

$$I_{MF} = \frac{I_Q}{(I_L * S_L) + (I_K * S_K)}$$

Where  $S_L$  = share of compensation of employees (as labour input) in value added  
 $S_K = 1 - S_L$  = share of other components (capital input) in value added  
 $I_L$  and  $I_K$  are index of the number of employees and index of the value of gross fixed assets respectively.

Multi-factor productivity growth measures have been developed as summary statistics to measure improvements in the efficiency of the production process—that come from technological progress and organizational change. They do so by comparing actual growth rates in output with the increase in output that would have been expected from an increase in inputs using preexisting or current production techniques. Table 5 presents the multi-factor productivity index during 1990-91 to 2010-11. From the table it is observed that multi-factor productivity index is increasing during the period. In 1990-91 the multi-factor productivity index was 0.32 and increased to 1.06 in 2007-08 and 1.01 in 2010-11. The increase of multi-factor productivity index implies both labour and capital are efficiently and effectively used in the organized manufacturing sector. Figure 5 clearly shows the upward trend of the multi-factor productivity index during the period.

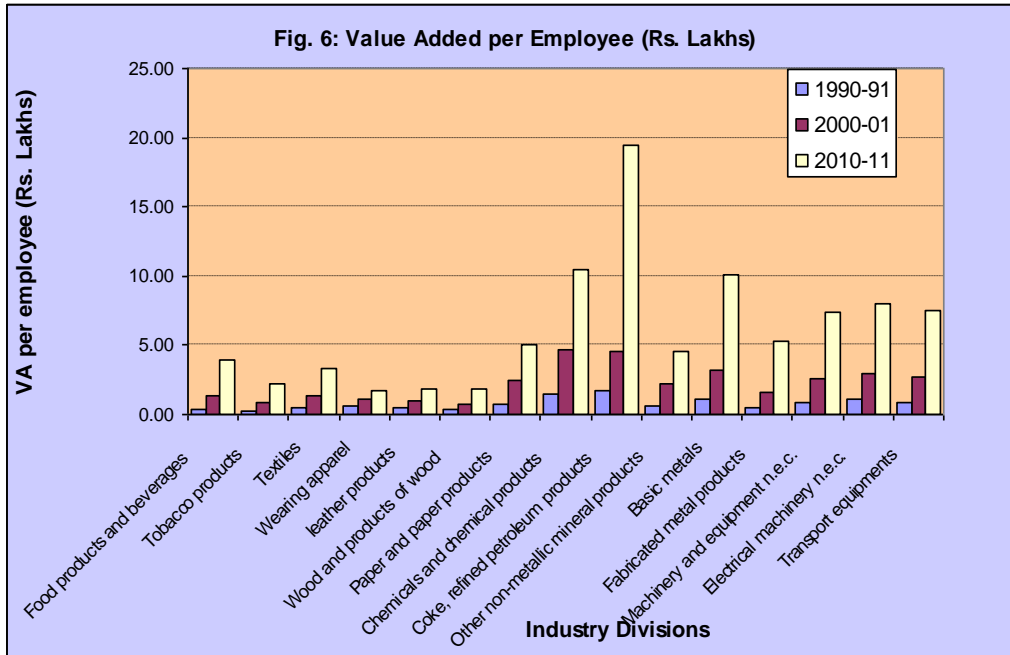


### Productivity in Industry Divisions

In the earlier sections we discussed on the productivity at all India level by considering organized manufacturing sectors. Now the following section will discuss productivity by considering industry divisions during 1990-91, 2000-01 and 2010-11. In this section productivity measures are based on by considering single factor productivity. Broadly, value added per employee, value added per capital and capital per employee is used to measure the productivity during the period.

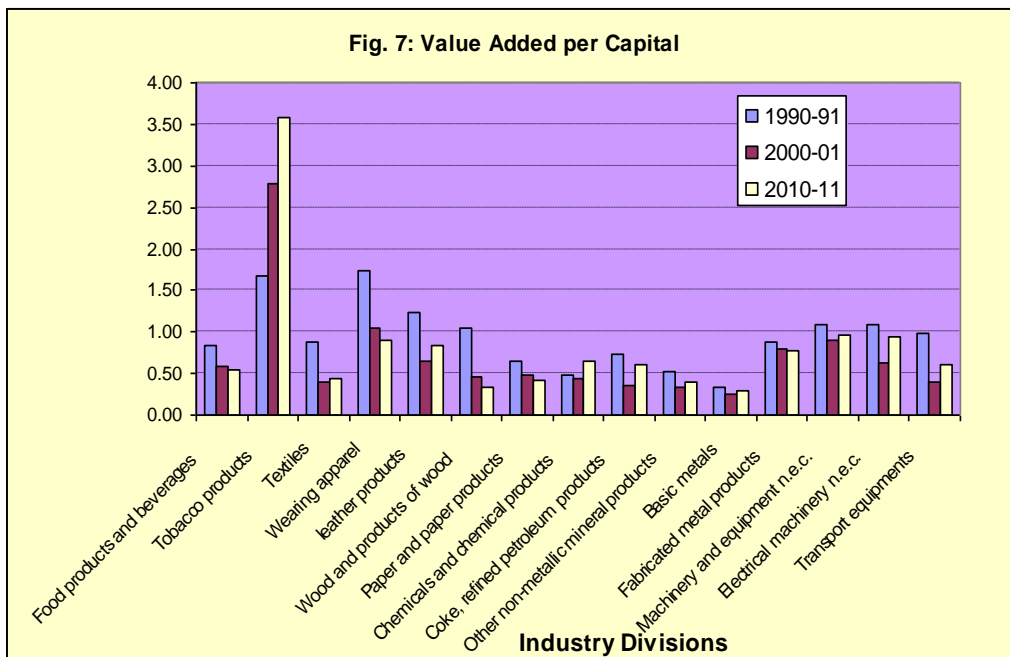
### Value Added per Employee

Table-6 presents the value added per employee during 1990-91, 2000-01 and 2010-11. From the table it is observed that value added per employee in 1990-91 is almost less than Rs. Lakhs except basic metals and electrical machinery. But over the period value added per employee is increasing drastically. Industry divisions viz. coke, refined petroleum products (Rs. 19.40 Lakhs), chemicals & chemical products (Rs. 10.52 lakhs), and basic metals (Rs. 10.05 lakhs) significant value addition is observed in 2010-11. Figure 6 clearly presents the value added per employee. From this analysis it is observed that labour productivity is increasing with respect to industry divisions. But there is significant difference observed in labour productivity with respect to industry divisions.



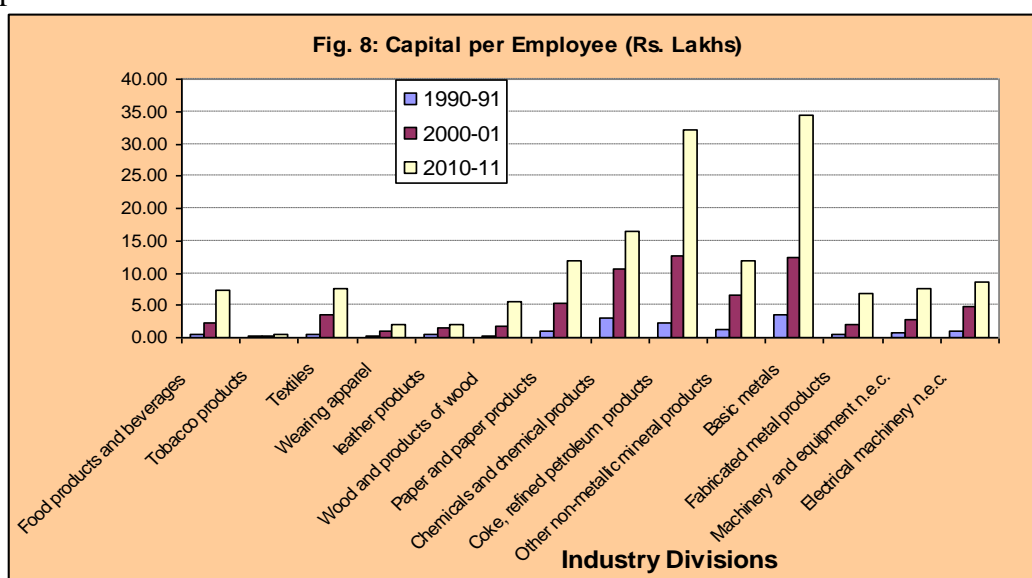
### Value Added per unit of Capital

Table-7 presents value added per unit of capital with respect to industry divisions during 1990-91, 2000-01 and 2010-11. From the table it is observed that value addition per unit of capital is declining with respect to industry divisions except tobacco products, and chemical & chemical products. It clearly reveals that industries are more capital intensive during the period. Figure 7 clearly presents the value added per unit of capital with respect to industry divisions.



## Capital per Employee

Capital per employee indicates the relation of the factors of production. Table-8 presents capital per employee with respect to industry divisions. From the table it is observed that capital per employee is drastically increased during the period with respect to industry divisions. Industry divisions viz. basic metals, coke, refined petroleum products, and chemicals & chemical products significantly capital per employee is increased during the period. It clearly indicates that industries are more capital intensive during the period. Even industries viz. food products & beverages, tobacco products, textiles, wearing apparel, wood & wood products, and paper & paper products are also implementing more capital in the production process. Figure 8 clearly shows the capital per employee during the period.



## Conclusion

This paper tried to explore the multi-factor productive in organized manufacturing sector during 1990-91 to 2010-11. From the analysis it has clearly concluded that the primary factors of production viz. labour and capital are optimally utilized in the production process. It has observed that labour productivity and capital productivity have increased during the period and their contribution has significant in the production process. Multi-factor productivity index has an upward trend which indicates the productivity with respect to labour and capital has increased during the period.

This paper also measures the capital intensity index. Capital intensity index has an upward trend which implies industries have implemented more fixed assets in the production process. It might be concluded that the fixed assets such as technology has the major role in the production process. By implementing technology and skilled labour, the productivity has increased during the period. This has also observed with respect to industry divisions. In earlier days those industries viz. food products & beverages,

tobacco products, textiles, wearing apparel, wood & wood products, and paper & paper products are mostly labour dominated and have implemented more capital in the form of technology in the production process.

It has strongly concluded that the productivity in organized manufacturing sector has increased during the period. Both labour and capital productivity have also increased during the period.

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UNIDO, 2010. Industrial Statistics Guidelines and Methodology, Vienna, United Nations.

**Table-2: Labour Productivity Index**

<b>Year</b>	<b>Production Index</b>	<b>Employment Index</b>	<b>Labour Productivity Index</b>
1990-91	16	97	17
1991-92	18	98	18
1992-93	22	104	21
1993-94	25	104	25
1994-95	31	109	29
1995-96	40	120	33
1996-97	44	113	39
1997-98	50	119	42
1998-99	47	102	46
1999-00	54	97	55
2000-01	55	94	59
2001-02	58	92	63
2002-03	68	94	72
2003-04	77	93	83
2004-05	100	100	100
2005-06	114	108	106
2006-07	144	122	118
2007-08	166	124	134
2008-09	196	134	146
2009-10	223	140	160
2010-11	280	151	186



**Table-3: Capital Productivity Index**

<b>Year</b>	<b>Production Index</b>	<b>Capital Stock Index</b>	<b>Capital Productivity Index</b>
1990-91	16	26	62
1991-92	18	30	60
1992-93	22	38	59
1993-94	25	44	58
1994-95	31	54	57
1995-96	40	68	59
1996-97	44	74	60
1997-98	50	82	61
1998-99	47	76	61
1999-00	54	78	69
2000-01	55	78	71
2001-02	58	84	68
2002-03	68	87	78
2003-04	77	92	83
2004-05	100	100	100
2005-06	114	118	96
2006-07	144	139	103
2007-08	166	165	101
2008-09	196	206	95
2009-10	223	264	85
2010-11	280	313	89

**Table-4: Capital Intensity Index**

<b>Years</b>	<b>Employment Index</b>	<b>Capital Stock Index</b>	<b>Capital Intensity Index</b>
1990-91	97	26	0.27
1991-92	98	30	0.30
1992-93	104	38	0.36
1993-94	104	44	0.42
1994-95	109	54	0.50
1995-96	120	68	0.57
1996-97	113	74	0.66
1997-98	119	82	0.69
1998-99	102	76	0.74
1999-00	97	78	0.80
2000-01	94	78	0.82
2001-02	92	84	0.92
2002-03	94	87	0.92
2003-04	93	92	0.99
2004-05	100	100	1.00
2005-06	108	118	1.10
2006-07	122	139	1.14
2007-08	124	165	1.33
2008-09	134	206	1.53
2009-10	140	264	1.88
2010-11	151	313	2.08

**Table 5: Multi-factor Productivity Index**

Year	Production Index	Labour Productivity Index	Capital Productivity Index	MFP
1990-91	16	17	62	0.32
1991-92	18	18	60	0.35
1992-93	22	21	59	0.37
1993-94	25	25	58	0.42
1994-95	31	29	57	0.45
1995-96	40	33	59	0.49
1996-97	44	39	60	0.53
1997-98	50	42	61	0.54
1998-99	47	46	61	0.56
1999-00	54	55	69	0.65
2000-01	55	59	71	0.67
2001-02	58	63	68	0.67
2002-03	68	72	78	0.76
2003-04	77	83	83	0.83
2004-05	100	100	100	1.00
2005-06	114	106	96	0.98
2006-07	144	118	103	1.06
2007-08	166	134	101	1.06
2008-09	196	146	95	1.03
2009-10	223	160	85	0.94
2010-11	280	186	89	1.01

**Table-6: Value Added per Employee with respect to Industry Divisions**

Industry Divisions	Value Added per Employee (Rs. Lakhs)		
	1990-91	2000-01	2010-11
Food products and beverages	0.42	1.41	3.90
Tobacco products	0.29	0.88	2.26
Textiles	0.48	1.33	3.31
Wearing apparel	0.56	1.10	1.77
leather products	0.48	1.00	1.80
Wood and products of wood	0.34	0.76	1.88
Paper and paper products	0.72	2.47	5.01
Chemicals and chemical products	1.43	4.70	10.52
Coke, refined petroleum products	1.73	4.57	19.40
Other non-metallic mineral products	0.67	2.23	4.59
Basic metals	1.14	3.24	10.05
Fabricated metal products	0.55	1.62	5.33
Machinery and equipment n.e.c.	0.83	2.59	7.41
Electrical machinery n.e.c.	1.05	2.92	8.04
Transport equipments	0.86	2.65	7.48

**Table-7: Value Added per unit of Capital with respect to Industry Divisions**

Industry Divisions	Value Added per unit of Capital		
	1990-91	2000-01	2010-11
Food products and beverages	0.83	0.59	0.54
Tobacco products	1.68	2.78	3.57
Textiles	0.88	0.39	0.44
Wearing apparel	1.74	1.04	0.90
leather products	1.23	0.65	0.84
Wood and products of wood	1.05	0.46	0.34
Paper and paper products	0.64	0.47	0.42
Chemicals and chemical products	0.49	0.44	0.64
Coke, refined petroleum products	0.73	0.36	0.60
Other non-metallic mineral products	0.53	0.34	0.39
Basic metals	0.33	0.26	0.29
Fabricated metal products	0.89	0.80	0.78
Machinery and equipment n.e.c.	1.08	0.90	0.97
Electrical machinery n.e.c.	1.08	0.62	0.94
Transport equipments	0.99	0.39	0.60

**Table-8: Capital per Employee with respect to Industry Divisions**

Industry Divisions	Capital per Employee (Rs. Lakhs)		
	1990-91	2000-01	2010-11
Food products and beverages	0.51	2.39	7.26
Tobacco products	0.17	0.32	0.63
Textiles	0.55	3.42	7.48
Wearing apparel	0.32	1.06	1.97
leather products	0.39	1.54	2.15
Wood and products of wood	0.32	1.67	5.56
Paper and paper products	1.12	5.21	11.97
Chemicals and chemical products	2.92	10.64	16.40
Coke, refined petroleum products	2.37	12.78	32.11
Other non-metallic mineral products	1.28	6.53	11.81
Basic metals	3.48	12.44	34.44
Fabricated metal products	0.62	2.02	6.79
Machinery and equipment n.e.c.	0.77	2.87	7.64
Electrical machinery n.e.c.	0.97	4.71	8.59
Transport equipments	0.87	6.72	12.46