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**DEPARTMENT OF ECONOMICS**

**ENERGY AND LABOUR USE  
IN THE ORGANISED MANUFACTURING SECTOR OF  
MAHARASHTRA**

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***Abstract***

The international experience of industrially advanced countries shows significant reduction in energy use per unit of output, which is often known as energy conservation in response to rising energy prices. Using ASI data this paper makes an attempt to understand behaviour of labour and energy use in the organized manufacturing sector of Maharashtra during 1980-81 to 1997-98. Both labour intensity and fuel intensity have declined significantly during the period across the industries in Maharashtra. However, the capital intensity registered a significant rise leading to increase in the total factor productivity in the manufacturing sector of Maharashtra. The differential rises in the prices of energy and labour induced industries to substitute fuel for labour in the manufacturing industries such as wood and wood products, paper and paper products, non-metallic mineral products, basic metal and alloys industries, and metal products.

However, fall in the fuel and labour intensity with rising capital intensity explains technological change is the factor behind rising total factor productivity in the manufacturing sector of Maharashtra.

***Key Words:*** Fuel Intensity, Labour Intensity, Capital Intensity, Agriculture-related Industries (AGRIND), Non-agriculture-related Industries (NAGRIND), Total factor Productivity.

***JEL Code(s):*** L60

# ENERGY AND LABOUR USE IN THE ORGANISED MANUFACTURING SECTOR OF MAHARASHTRA

L. G. Burange\*

## 1. Introduction:

This study makes an attempt to explore substitution between fuel and labour in the organised manufacturing sector of Maharashtra. International experience of industrially advanced countries shows significant reduction in energy use per unit of output, often referred to as energy conservation (Sweeney, 1984) in response to increasing energy prices. Energy Conservation means substitution of one input for another; capital for energy, labour for energy and so on, combinations of inputs responding to relative prices, and also reduction of waste in use of energy.

However, some Asian countries have recorded increases in energy consumption per unit of output with rapid increase in GDP. According to Ishiguro et al (1995), the Indian manufacturing sector has obsolete facilities and processes, which are responsible for high-energy consumption. The energy management is also poor in the modern areas. The energy intensity in some machinery and fabrication industries has increased as they have changed from labour-intensive to energy-intensive ways of production. In this regard we raise some specific questions. How far is the organised manufacturing sector of Maharashtra dependent on energy? Is there any possibility of substitution of energy for labour? However, choice of technology plays important role in determination of proportions of inputs in the production, viz. labour, energy and capital, and also

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substitution among these inputs. Of course, longer the period more are the chances of technological improvement and therefore wider will be the variability in the factor intensity in the production of manufacturing industries.

The paper is organized as follow. Section two discusses the sources of data and adjustments required in data and its coverage. Section three analyses different factor intensities, while effect of changing prices of fuel and labour on substitution between fuel and labour is discussed in section four. Section five discusses the growth of total factor productivity and finally section six concludes.

## **2. Data Adjustment and Coverage:**

The Annual Survey of Industries - Summary Results for Factory Sector is the main source of data. Since the Annual Survey of Industries does not cover the unorganised small-scale industrial units, this exercise is confined to the organised manufacturing sector only. Monthly Bulletin of Index Numbers of Wholesale Prices in India is also used for the data on prices. Following Desai et al (1991), all agriculture related industries, NIC 20-21 to NIC 29 are clubbed together under AGRIND and all non-agriculture-related industries, NIC 30 to NIC 39, are clubbed together under NAGRIND, in this exercise. We cover the period from 1980-81 to 1997-98. For labour we consider the number of workers only. For estimating the value of output at constant prices the Wholesale Price Index of India from Monthly Bulletin of Wholesale Prices of India have been used. The value of output of an industry is deflated by the wholesale price index for the output of that industry. Aggregating the values at constant prices at the individual industrial outputs gives the aggregate value of output of the organised manufacturing sector at constant prices for the state. Annual Survey of Industries does not give us the energy consumption figures directly. It gives the total quantity of fuel, the source of energy, consumed by the industrial categories. Annual Survey of Industries defines fuel as the combination of the total purchase value of electricity, oil and lubricants and coal consumed in the production process. However, these fuel consumption expenditure figures are given in nominal terms. To get the figures in real

terms we need an approximate price deflator. A wholesale price index number is readily available for this composite category at the all-India level. Within the fuel group, only electricity prices are determined by the state governments and likely to vary from state to state. Now a days electricity is the major source of energy in the industrial sector. Moreover, some industrial establishments have their own (captive) power generation units. This means that these firms buy coal and other fuels to generate electricity rather than buying electricity directly. Considering all these factors we have decided to use the all-India wholesale price index number for the fuel. However, we have the price index numbers for fuel and to get compatibility we have converted average wages of production workers in the industry into wage index with 1981-82 as base. A composite index of the wholesale price indices of building materials, manufacture of electrical and non-electrical machinery, machine tools and parts, and transport equipment and parts has been used for deflating the values of fixed capital.

Here, we use the gross fixed capital stock as a measure of capital input. To construct the time series of gross fixed capital stock we assume that the value of finished equipment of balanced age composition would be exactly half the value of equipment when it was new. Hence, we have taken twice the book value of the base year as a rough estimate of the replacement value of fixed capital. Banerji (1975), Goldar (1986), Kumar (2001) and some others have followed this method of estimating fixed capital for the benchmark year in their works. It is certainly arbitrary. According to Goldar (1986), 'even if it is assumed that fixed assets comprising that stock have a balanced age distribution, the fact that life of machines exceeds what would be inferred from the depreciation practices of firms and that price of capital goods were rising over time imply that the ratio of replacement value to book value should significantly exceed two'. Despite this limitation, we followed this method because Hashim and Dadi like gross/net ratios (1973) are not available at the state level. Therefore, doubling the book value of capital has been considered as an approximate method for arriving at replacement value of the fixed capital for benchmark year at the state level. Then using the following equation the measurement of gross fixed capital series at 1981-82 price is derived.

$$K_t = K_{t-1} + I_t - dK_{t-1} \dots\dots\dots(1)$$

where,

$K_t$  = Gross fixed capital at 1981-82 prices at the end of year t

$I_t$  = Gross real investment in fixed capital during the year t

d = Annual rate of discard of capital

Following Goldar (1986), we have assumed two per cent annual rate of discard of capital.

Then the gross real investment  $I_t$  is estimated by following equation

$$I_t = (B_t - B_{t-1} + D_t) / P_t \dots\dots\dots(2)$$

where,

$B_t$  = Book value of fixed capital in the year t

$D_t$  = Depreciation in the year t, and

$P_t$  = Price index of building materials, manufacture of machinery, machine tools & parts and transport equipment and parts (1981-82 = 100)

To estimate Total Factor Productivity Growth we have used gross value added as measure of output. The wholesale price index for manufacturing products (1981-82 = 100) is used for arriving at real figures of gross value-added.

### **3. Factor Intensities:**

Factor intensity in the production process is defined as the amount of a specific factor required to produce one unit of output. During 1980-81 to 1997-98, number of workers in the manufacturing sector of Maharashtra did not register any increase. The real output increased by 8.07 per cent per annum; while fuel and fixed capital increased respectively by 7.84 per cent and 10.08 per cent per annum. This differential growth rates imply changes in the factor intensities in the organised manufacturing sector of the state.

At the level of manufacturing sector the fuel intensity shows declining trend over the period of 1980-81 to 1997-98, (Table 1). This is consistent with the international experience of energy conservation. However, the fall in the fuel intensity is not continuous, during 1986-87 to 1991-92 the manufacturing sector registered rise in the fuel intensity. This is a period when the economy experienced import liberalisation, and industries were allowed to utilize illegal installed capacities, which resulted into increase in the utilization of resources.

**Table 1**

Factor Intensity in the Organised Manufacturing Sector (Mfg (2-3)) of Maharashtra.  
(@Constant Prices, 1981-82 = 100)

Year	Fuel Intensity (FU/VO)	Labour Intensity		Capital Intensity (FC/VO)
		Wage/Output (WW/VO)	Labour/Output (NW/VO)*	
1980-81	0.050	0.065	0.632	0.422
1981-82	0.047	0.055	0.575	0.414
1982.-83	0.043	0.055	0.518	0.406
1983.84	0.050	0.058	0.479	0.440
1984-85	0.047	0.058	0.443	0.448
1985-86	0.044	0.054	0.397	0.430
1986-87	0.053	0.054	0.385	0.449
1987-88	0.054	0.053	0.371	0.463
1988-89	0.051	0.050	0.342	0.476
1989-90	0.053	0.048	0.297	0.471
1990-91	0.051	0.041	0.257	0.436
1991-92	0.055	0.045	0.286	0.524
1992-93	0.055	0.040	0.256	0.508
1993-94	0.048	0.036	0.231	0.508
1994-95	0.048	0.036	0.213	0.509
1995-96	0.046	0.034	0.195	0.504
1996-97	0.048	0.033	0.205	0.622
1997-98	0.039	0.028	0.176	0.551

\* To produce output of Rs.1 lakh the required number of workers.

FU = Fuels.

WW = Total Wages to Workers.

FC = Fixes capital Stock.

NW = Number of Workers.

VO = Value of Output (Real Output).

Labour intensity in terms of number of workers per unit of output recorded a continuous decrease over the entire period 1980-81 to 1997-98. This means over this period manufacturing sector of Maharashtra uses less and less labour. Even in terms of wage per unit of output, labour intensity is decreasing continuously. This means the labour cost in production of manufacturing sector of the state is continuously decreasing.

Contrary to fuel and labour intensities capital intensity registered a steady increase over the period in the manufacturing sector of Maharashtra. This steady increase in capital intensity indicates that the production in the manufacturing sector of Maharashtra is becoming more and more capital intensive. The change in factor intensity can take place due to various reasons. The time period concerned is quite long so that the possibilities of technological change are imminent. Technological change can result into change in factor proportions. During such a long period a significant change in the output composition may change the factor intensity. Increase in the efficient use of a factor can also change factor intensity.

### *3.1 Fuel Intensity:*

Fall in fuel intensity in the manufacturing sector of Maharashtra during 1980-81 to 1997-98, does not indicate that all the industries at two-digit level experiencing a fall in fuel intensity. During 1980-81 to 1997-98 beverages, tobacco and tobacco products (22), cotton textiles (23), wood and wood products (27), paper and paper products (28), non-metallic mineral products (32), basic metal and alloys industries (33) and metal products (34) recorded increase in the fuel intensity, (Table 2). The industries such as textile products (26) transport equipment and parts (37) and other manufacturing industries (38), etc. recorded substantial fall in the fuel intensity during this period. By splitting this entire period 1980-81 to 1997-98 into pre-liberalisation period (1980-81 to 1991-92) and post-liberalisation period (1991-92 to 1997-98), the growth rate of fuel intensity substantially varies across the industries in the manufacturing sector of



Maharashtra. During pre-liberalisation period manufacturing sector experienced a rise in fuel intensity by 1.49 per cent per annum and mostly this rise comes in from the Non-agriculture-related industries (NABARD). The industries such as cotton textiles (23), wood and wood products (27), paper and paper products (28), leather and leather products (29), non-metallic mineral products (32), basic metal and alloys industries (33) and metal products (34) recorded increase in the fuel intensity. However, textile products (26) and other manufacturing industries (38) are the industries, which recorded a substantial decrease in fuel intensity.

**Table 2**

Annual Compound Growth Rate of Fuel Intensity in the  
Organised Manufacturing Sector of Maharashtra.  
(@Constant Prices, 1981-82 = 100)

(Per cent)

<b>Industry Code Number</b>	<b>1980-81 to 1997-98</b>	<b>1980-81 to 1991-92</b>	<b>1991-92 to 1997-98</b>
20-21	0.42*	1.03*	(-) 1.01*
22	2.48	2.57*	2.28*
23	1.80	2.32	0.60*
24	0.09*	0.33*	(-) 0.48*
25	-	-	-
26	(-) 2.40	(-)3.53	0.33*
27	5.87	5.14	7.62
28	2.69	7.05	(-) 6.96
29	(-) 0.11*	3.71	(-) 8.65
30	(-) 0.78*	1.26*	(-) 5.49
31	0.56*	0.11*	1.65*
32	2.71	3.57	0.70*
33	1.74	4.21	(-) 3.91
34	4.99	8.21	(-) 2.29
35-36	(-) 0.58*	0.77*	(-) 3.70
37	(-) 1.22	0.88*	(-) 6.06
38	(-) 7.33	(-)7.38	(-) 7.22
39#	(-) 5.86	-	-
Mfq. (2-3)	(-) 0.20*	1.49	(-) 4.12
AGRIND	(-) 0.30*	0.55*	(-) 2.27
NAGRIND	(-) 0.07*	1.95	(-) 4.69

\* Insignificant at 5% level of significance.

# Data are available from 1989-90.

During 1991-92 to 1997-98 (post-liberalisation) only wood and wood products (27), recorded increase in the fuel intensity. The industries such as paper and paper products (28), leather and leather products (29), chemical and chemical products (30), basic metal and alloys industries (33), metal products (34), machinery, machine and parts (35-36), transport equipments (37) and other manufacturing industries (38) recorded a substantial decrease in fuel intensity. However, overall the manufacturing sector registered a substantial fall in the fuel intensity but it is more pronounced in the NAGRIND during post-liberalization period.

### 3.2 *Labour intensity:*

In case of labour intensity (number of workers per unit of output), all the industries in the manufacturing sector of Maharashtra experienced a substantial fall during 1980-81 to 1997-98, (Table 3). However, this fall in the labour intensity is relatively higher in cotton textiles (26), chemical and chemical products (30), non-metallic mineral products (32), basic metal and alloys industries (33), machinery, machine and parts (35-36), transport equipment and parts (37) and other manufacturing industries (38). This decrease in the labour intensity is more pronounced during the pre-liberalisation period than the post-liberalisation period. However, this decrease is relatively more in the non-agriculture-related industries (NAGRIND) than that in the agriculture – related industries (AGRIND).

The labour intensity in terms of wage cost per unit of output registered a fall in the manufacturing sector of Maharashtra. It means the labour cost compared to output has gone down in the manufacturing sector of Maharashtra during 1980-81 to 1997-98. This decrease in the wage cost per unit of output is very pronounced in textile products (26), basic metal and alloys industries (33), transport equipment and parts (37) and other manufacturing industries (38), (Table 4).

The labour cost per unit of output is decreased relatively at higher rate during the post-liberalisation period than that during the pre-liberalisation period. However, this fall is relatively more in non-agriculture-related industries (NAGRIND) than that in the agriculture-related industries (AGRIND) during post-liberalisation period in the manufacturing sector of Maharashtra.

**Table 3**

Annual Compound Growth Rate of Labour Intensity in the  
Organised Manufacturing Sector of Maharashtra.  
(@Constant Prices, 1981-82 = 100)

(Per cent)

Industry Code Number	1980-81 to 1997-98	1980-81 to 1991-92	1991-92 to 1997-98
20-21	(-) 5.91	(-) 7.04	(-) 3.17*
22	(-) 2.23	(-) 1.45*	(-) 4.05*
23	(-) 4.09	(-) 5.24	(-) 1.29*
24	(-) 6.27	(-) 6.21	(-) 6.41
25	-	-	-
26	(-) 7.90	(-) 10.41	(-) 1.65*
27	(-) 2.09*	(-) 2.77*	(-) 0.46*
28	(-) 5.96	(-) 5.74	(-) 6.50
29	(-) 5.18	(-) 4.12	(-) 7.66
30	(-) 7.41	(-) 7.17	(-) 7.97
31	(-) 4.98	(-) 7.89	2.29*
32	(-) 7.52	(-) 8.61	(-) 4.87
33	(-) 7.15	(-) 8.00	(-) 5.11
34	(-) 4.54	(-) 3.55	(-) 6.83
35-36	(-) 7.12	(-) 7.37	(-) 6.51
37	(-) 9.51	(-) 9.17	(-) 10.31
38	(-) 11.99	(-) 12.07	(-) 11.81
39#	(-) 9.52	-	-
Mfq. (2-3)	(-) 7.02	(-) 7.39	(-) 6.13
AGRIND	(-) 6.03	(-) 6.62	(-) 4.63
NAGRIND	(-) 6.92	(-) 7.26	(-) 6.11

\* Insignificant at 5% level of significance.

# Data are available from 1989-90.

**Table 4**

Annual Compound Growth Rate of Wage Cost Per Unit of Output  
in the Organised Manufacturing Sector of Maharashtra.  
(@Constant Prices 1981-82 = 100)

Industry Code Number	(Per cent)		
	1980-81 to 1997-98	1980-81 to 1991-92	1991-92 to 1997-98
20-21	(-) 0.70*	0.50*	(-) 3.47
22	(-) 1.07	0.24*	(-) 4.12
23	(-) 2.35	(-) 2.02	(-) 3.12
24	(-) 4.83	(-) 3.10	(-) 8.84
25	-	-	-
26	(-) 5.71	(-) 6.89	(-) 2.84
27	(-) 0.69*	0.19*	(-) 2.76*
28	(-) 3.57	(-) 2.69	(-) 5.64
29	(-) 2.44*	3.82*	(-) 15.86
30	(-) 4.91	(-) 2.52	(-) 10.35
31	(-) 2.55	(-) 4.10	1.23*
32	(-) 3.93	(-) 4.53	(-) 2.51
33	(-) 5.77	(-) 5.24	(-) 7.03
34	(-) 2.81	(-) 0.51*	(-) 8.07
35-36	(-) 3.69	(-) 2.07	(-) 7.43
37	(-) 5.14	(-) 3.66	(-) 8.56
38	(-) 10.47	(-) 10.03	(-) 11.50
39#	(-) 7.56	-	-
Mfg. (2-3)	(-) 4.25	(-) 3.24	(-) 6.61
AGRIND	(-) 4.01	(-) 3.27	(-) 5.74
NAGRIND	(-) 4.08	(-) 2.95	(-) 6.71

\* Insignificant at 5% level of significance.

# Data are available from 1989-90.

### 3.3 Capital Intensity:

Capital intensity means the capital required to produce one unit of output. The capital intensity in the manufacturing sector of Maharashtra recorded a rise during 1980-81 to 1997-98 and this increase is relatively higher in agriculture-related industries (AGRIND) than that in non-agriculture-related industries (NAGRIND), (Table 5). The

industries such as beverages, tobacco and tobacco products (22), wool, silk and synthetic fibre products (24), wood and wood products (27), paper and paper products (28), rubber, plastic, petroleum and coal products (31), non-metallic mineral products (32), basic metal and alloys industries (33) and metal products (34) recorded relatively higher increase in the capital intensity during 1980-81 to 1997-98, whereas transport equipment parts (37) and other manufacturing industries (38) recorded a fall in the capital intensity.

**Table 5**

Annual Compound Growth Rate of Capital Intensity in the  
Organised Manufacturing Sector of Maharashtra.  
(@Constant Prices, 1981-82 = 100)

Industry Code Number	(Per cent)		
	1980-81 to 1997-98	1980-81 to 1991-92	1991-92 to 1997-98
20-21	(-) 0.34*	(-) 1.18*	1.69*
22	6.51	5.43	9.11
23	3.35	1.29*	8.42
24	5.22	2.05	13.18
25	-	-	-
26	(-) 0.11*	(-) 3.24	7.74
27	7.53	8.11	6.16*
28	4.03	4.86	2.08*
29	1.14*	1.91*	(-) 0.67*
30	0.41*	0.95	(-) 0.85*
31	5.54	1.93*	14.64
32	9.02	11.20	4.02
33	6.71	7.66	4.47
34	4.60	4.79	4.16
35-36	0.39*	0.57*	(-) 0.04*
37	(-) 1.52	(-) 0.84*	(-) 3.09
38	(-) 7.80	(-) 10.10	(-) 2.08*
39#	(-) 2.00*	-	-
Mfq. (2-3)	1.87	1.52	2.69
AGRIND	1.93	0.42*	5.60
NAGRIND	1.86	1.91	1.74

\* Insignificant at 5% level of significance.

# Data are available from 1989-90.

During pre-liberalisation some industries such as wood and wood products (27), paper and paper products (28), non-metallic mineral products (32), basic metal and alloys industries (33) and metal products (34) recorded higher increase in the capital intensity. Only textile products (26) and other manufacturing industries (38) recorded a fall in the capital intensity during the pre-liberalisation period. However, this rise in capital intensity during pre-liberalisation period was higher in the non-agriculture-related industries (NAGRIND).

A substantial rise in the capital intensity is recorded by the agriculture-related industries during post-liberalisation period. Post-liberalisation period witnessed high increase in the capital intensity in the manufacturing sector of Maharashtra. However, the industries such as beverages, tobacco and tobacco products (22), cotton textiles (23) wool, silk and synthetic fibre (24), textile products (26) and rubber, plastic, petroleum and coal products (31) recorded relatively higher increase in capital intensity during post-liberalisation period in the manufacturing sector of Maharashtra. During post-liberalisation period the capital intensity recorded acceleration in the growth rate.

The labour intensity witnessed a fall across the industries in the manufacturing sector of Maharashtra. Same is the case with fuel intensity. Only capital intensity shows rising trend, this indicates that the production in the manufacturing sector of Maharashtra is becoming relatively more capital intensive.

#### **4. Substitution between Fuel and Labour:**

The table 6 shows that the cost of labour has increased more sharply than that of fuel during 1980-81 to 1997-98. The increase in wage rate is 12.24 per cent per annum while that of fuel price is 8.60 per cent per annum during 1980-81 to 1997-98. In fact rise in wage rate is much higher during 1980-81 to 1991-92 (pre-liberalisation) than that of fuel prices during the same period. However, during 1991-92 to 1997-98 (post-liberalisation) fuel prices registered higher growth than that of wage rate. Therefore, a possibility of substitution between fuel and labour as response to the change in relative

prices exists during these different time periods in the manufacturing sector of Maharashtra.

**Table 6**

Indices of Wage Rate and Fuel Price.  
(1981-82=100)

<b>Year</b>	<b>Wage Rate Index</b>	<b>Fuel Price Index</b>
1980-81	87.6	80.0
1981-82	100.0	100.0
1982-83	114.1	106.5
1983-84	141.9	112.5
1984-85	162.6	117.3
1985-86	180.3	129.8
1986-87	202.8	138.6
1987-88	222.5	143.3
1988-89	248.8	151.2
1989-90	290.4	156.6
1990-91	320.6	175.8
1991-92	360.6	199.0
1992-93	390.9	227.1
1993-94	422.9	262.4
1994-95	489.2	280.4
1995-96	566.8	285.4
1996-97	575.2	324.2
1997-98	612.9	365.7

Wage Rate Index: Annual Compound Growth Rate (ACGR) Per cent

- (1) 1980-81 to 1997-98 → 12.24
- (2) 1980-81 to 1991-92 → 13.48
- (3) 1991-92 to 1997-98 → 9.36

Fuel Price Index: Annual Compound Growth Rate (ACGR) Per cent

- (1) 1980-81 to 1997-98 → 8.60
- (2) 1980-81 to 1991-92 → 7.59
- (3) 1991-92 to 1997-98 → 11.03

The elasticity of substitution is the ratio of the proportionate change in the factor proportions to the proportionate change in the slope of the isoquant. It is implicitly assumed that entrepreneur is rational and thus the cost is minimised, the slope of isoquant is equal to relative factor prices. Therefore, in other words elasticity of substitution is the ratio of the proportionate change in factor proportions to proportionate change in relative factor prices. Thus elasticity of substitution can explain the effect of increase in fuel prices on the level of employment, given the other factors of production constant.

Using following equation we estimated elasticity of substitution between fuel and labour during 1980-81 to 1997-98 for two-digit industries in the manufacturing sector of Maharashtra.

$$\ln (q_1/q_2) = a + b \ln (p_1/p_2) \dots\dots\dots (3)$$

where,

$q_1$  and  $q_2$  are quantities (wage bill and fuel expenditure at constant prices) of labour and fuel,  $p_1$  and  $p_2$  are wage rate index and fuel price index respectively.

Table 7 shows that the elasticity of substitution between fuel and labour during 1980-81 to 1997-98 is significant in all the two-digit industries in the manufacturing sector except food products (20-21). The industries such as wood and wood products (27), paper and paper products (28) non-metallic mineral products (32), basic metal and alloys industries (33), and metal products (34) show relatively high substitution between fuel and labour during 1980-81 to 1997-98 in Maharashtra. Thus, the high elasticity of substitution between fuel and labour shows the possibility of opting for fuel-intensive production process rather than a labour-intensive one when the increase in wage rate is comparatively higher than the increase in fuel prices.



**Table 7**

Elasticity of Substitution between Fuel and Labour in the Organised Manufacturing Sector of Maharashtra.

Industry Code Number	1980-81 to 1997-98	t-value	R-Squared
20-21	(-) 0.09*	(-) 1.4046	0.1098
22	(-) 0.93	(-) 2.0188	0.2030
23	(-) 0.97	(-) 3.9684	0.4960
24	(-) 0.90	(-) 2.1869	0.2301
25	-	-	-
26	(-) 0.94	(-) 3.6375	0.4526
27	(-) 1.23	(-) 2.4507	0.2729
28	(-) 1.84	(-) 6.6647	0.7352
29	(-) 0.40	(-) 2.6031	0.2975
30	(-) 0.78	(-) 2.9558	0.3532
31	(-) 0.63	(-) 2.7974	0.3284
32	(-) 1.41	(-) 9.0691	0.8371
33	(-) 2.20	(-) 4.5493	0.5640
34	(-) 1.16	(-) 2.2271	0.2367
35-36	(-) 0.56	(-) 4.7946	0.5896
37	(-) 0.72	(-) 10.4710	0.8727
38	(-) 0.69	(-) 2.5924	0.2958
39#	-	-	-
Mfq. (2-3)	(-) 0.95	(-) 6.4057	0.7195
AGRIND	(-) 0.93	(-) 4.7699	0.5871
NAGRIND	(-) 0.94	(-) 6.1198	0.7007

\* Insignificant at 5% level of significance.

# Data are available from 1989-90.

$$\ln(q_1/q_2) = a + b \ln(p_1/p_2) \dots\dots\dots(3)$$

## 5. Total Factor Productivity:

The fuel intensity and labour intensity are decreasing while capital intensity is increasing. It clearly indicates the technological improvement over the period of time.

Following Goldar and Kumari (2002), we use two-input framework for the estimates of total factor productivity. For the two-input framework the translog index of TFP growth is given by the following expression :

$$\Delta \ln TFP_{(t)} = \Delta \ln Y_{(t)} - \left[ \frac{SL_{(t)} + SL_{(t-1)}}{2} \times \Delta \ln L_{(t)} \right] - \left[ \frac{SK_{(t)} + SK_{(t-1)}}{2} \times \Delta \ln K_{(t)} \right] \dots\dots(4)$$

Here, Y is output (Value-added), L Labour and K Capital, t is time period.

$$\Delta \ln L_{(t)} = \ln L_{(t)} - \ln L_{(t-1)}, \text{ and}$$

$$\Delta \ln K_{(t)} = \ln K_{(t)} - \ln K_{(t-1)}.$$

SL is the income share of labour (in value added) and SK denotes the income share of capital. SL and SK add up to unity.  $\Delta \ln TFP$  is the rate of technological change or the rate of growth of total factor productivity.

Using above equation the growth rates of TFP have been estimated for each year. These have been used to obtain an index of TFP in the following manner. Let A denote the index of TFP. For the base year  $A_{(0)}$  is the index, which is taken as 100. Then for subsequent years index is computed as follow:

$$A_{(t)}/A_{(t-1)} = \exp[\Delta \ln TFP_{(t)}] \dots\dots\dots(5)$$

Having obtained the TFP index for different years, estimates of TFP growth rate have been estimated for different periods, 1980-81 to 1991-92; (pre-liberalisation), 1991-92 to 1997-98, (post-liberalisation) and for entire period that is 1980-81 to 1997-98. The estimation of TFP growth rate for the entire period has been done by semi-log method. To obtain the growth rates for the sub-periods the ‘Kinked Exponential Model’ has been used.

Table 8 shows that during 1980-81 to 1997-98 period total factor productivity in the manufacturing sector of Maharashtra increased by 0.87 per cent per annum. The

agriculture-related industries recorded very pronounced growth in total factor productivity. Nevertheless, the industries such as non-metallic mineral products (32), metal products and parts (34) and beverages, tobacco and tobacco products (22) experienced a fall in total factor productivity during this period.

**Table 8**

Annual Compound Growth Rate of Total Factor Productivity  
in the organised Manufacturing Sector in Maharashtra.  
(@ Constant Prices 1981-82 = 100)

(Per cent)

Industry Code Number	1980-81 to 1997-98	1980-81 to 1991-92	1991-92 to 1997-98
(1)	(2)	(3)	(4)
20-21	4.76	6.63	0.45*
22	(-) 1.30	0.10*	(-) 4.52
23	0.80*	0.03*	2.65*
24	(-) 1.78*	1.44*	(-) 9.02
25	-	-	-
26	3.75	9.39	(-) 8.51
27	1.50*	(-) 1.31*	8.49*
28	0.62*	1.27*	(-) 0.93*
29	3.51*	10.39	(-) 11.17
30	1.55	1.04*	2.79*
31	(-) 1.10*	4.53*	(-) 13.30
32	(-) 4.43	(-) 4.16	(-) 5.10*
33	(-) 1.30*	(-) 5.36*	9.08*
34	(-) 1.22	(-) 0.24*	(-) 3.51*
35-36	1.48	2.58	(-) 1.08*
37	3.31	3.21	3.54
38	2.76	4.43	(-) 1.10*
39#	-	-	-
Mfq. (2-3)	0.87	1.79	(-) 1.29*
AGRIND	1.12	3.08	(-) 3.39
NAGRIND	0.50*	1.03*	(-) 0.74*

\* Insignificant at 5% level of significance.

# Data are available from 1989-90.

During the pre-liberalisation period the manufacturing sector of Maharashtra experienced a pronounced rise in the total factor productivity. This rise is mainly in the agriculture-related industries (AGRIND). The industries such as food and food products (20-21), textile products (26), leather and leather products (29), other manufacturing industries (38) and transport equipment and parts (37) recorded high growth in total factor productivity during the pre-liberalisation period. However, non-metallic mineral products (32) registered very high decrease in the total factor productivity during this period. However, the trend of rising total factor productivity completely reversed during the post-liberalisation period in the manufacturing sector of Maharashtra. The large number of industries experienced a substantial fall in total factor productivity during the post-liberalisation period. This trend is more pronounced in the AGRIND in the manufacturing sector of Maharashtra.

One of the possible explanations for decelerations in the total factor productivity growth during the post-liberalisation period in the manufacturing sector of Maharashtra may be a gestation lag. During post-liberalisation period investment activity in the industrial sector increased and this is shown by the growth rate of Gross Fixed Capital. During post-liberalisation period Gross Fixed Capital increased by 13.65 per cent per annum (Burange, 2003). This rise in capital in the manufacturing sector might have had an immediate adverse effect on productivity due to gestation lags. Goldar and Kumari (2002) have made analysis on same line for the Indian manufacturing sector. According to them, slow down in agricultural growth in the 1990s seems to be important cause of deceleration in total factor productivity growth in the Indian industries in the 1990s. According to Uchikawa (2001) the investment boom in the Indian industries in the first half of 1990s had adverse effect on productivity. This lumpy investment revised the output sharply, the demand did not expand as much as capacity. This situation led to under utilisation of capacity and thus had deceleration in productivity growth. The same thing might have happened in the manufacturing sector of Maharashtra too.

## **6. Conclusions:**

According to the international experience of industrially advanced countries lead to a fall in the fuel and labour intensity.

For the manufacturing sector of Maharashtra for the period 1980-81 to 1997-98, the labour intensity decreased substantially along with a fall in the fuel intensity. This is consistent with the international experience. However, the capital intensity, during this period recorded rising trend, which indicates the technological change in the manufacturing sector of Maharashtra during this period.

Although, the fuel and labour intensities have declined in the manufacturing sector but fuel prices and wage rates have increased during 1980-81 to 1997-98 inducing the industries to substitute fuel for labour. In the manufacturing sector of Maharashtra wage rates have increased much faster than the fuel prices which induced the industries such as wood and wood products (27), paper and paper products (28), non-metallic mineral products (32), basic metal and alloys industries (33) and metal products (34) to substitute fuel for labour during this period.

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## Appendix 1

**Table A1:** National Industrial Classification for Two-digit Industries.

<b>Industry Code</b>	<b>Description of Industry</b>
20-21	Mfg. of food and food products.
22	Mfg. of beverages, tobacco and tobacco products.
23	Mfg. of cotton textiles.
24	Mfg. of wool, silk and synthetic fibre products.
25	Mfg. of jute, hemp and mesta textiles.
26	Mfg. of textile products.
27	Mfg. of wood and wood products, furniture and fixtures.
28	Mfg. of paper and paper products.
29	Mfg. of leather and leather products.
30	Mfg. of chemical and chemical products.
31	Mfg. of rubber, plastic, petroleum and coal products.
32	Mfg. of non-metallic mineral products.
33	Basic metal and alloys industries.
34	Mfg. of metal products and parts except machinery.
35-36	Mfg. of machinery, machine and parts.
37	Mfg. of transport equipment and parts.
38	Other manufacturing industries.
39	Repair of capital goods.
<b>Mfg. (2-3)</b>	<b>Manufacturing.</b>