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# Growth of Industrial Production in Selected Indian Manufacturing Industries: Is It Productivity Driven or Input Accumulated?

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**Abstract:**

The present article attempts to examine the contribution of inputs and total factor productivity growth to the growth of output by considering the aggregate manufacturing sector and seven selected manufacturing industries of India during the period 1979-80 to 2003-04. Major findings of the study indicate that output growth in the selected Indian manufacturing industrial sectors is driven mainly by inputs accumulation while the contribution of total factor productivity growth remains either minimal or negative. The growth rate of total factor productivity in almost all the industries under our study is gradually declining, especially during the post-reforms period. The change in pattern of sources of output growth may have taken place due to liberalization policies and structural reforms undertaken during the 1990s.

**Key words:** Growth, productivity, input, manufacturing, industry, India.

## 1. Introduction:

India has been adopting a highly protective industrial and foreign trade regime since 1951. The liberalisation of Indian economy initiated slowly in the 1980's and key economic liberalisations via structural adjustment programs began from 1991. By virtue of this programme, intensive charges have been made in industrial policy of India Government. Relaxing of licensing rule, reduction tariff rates, removal of restrictions on import etc are among those which have been initiated at early stage. The policy reforms had the objectives to make Indian industries as well as entire economy more efficient, technologically up-to-date and competitive. This was done with the expectation that efficiency improvement, technological up-gradation and competitiveness would ensure Indian industry to achieve rapid growth. In view of greater openness of Indian economy due to trade liberalization, private sector can build and expand capacity without any regulation.Earlier,the protective regime not only prohibited entry into industry and capacity expansion but also technology, output mix and import content. Import control and tariff provided high protection to domestic industry. There was increasing recognition by the end of 1980's that the slow and inefficient growth experienced by Indian industry was the result of a tight regulatory system provided to the Indian industry.

The logic that manufacturing industries play a special role in the growth process involves two related propositions: (i) that manufacturing activity contributes to overall growth in ways not reflected in conventional output measures; and (ii) that this growth premium is larger in the case of manufacturing relative to its output share than for other sectors of the economy. According to Cornwall (1977), the manufacturing sector would act as engine of growth for two reasons –it displays dynamic economies of scale through "learning by doing" (Young, 1928, Kaldor, 1966,1967).With increased output, the scope for learning and productivity increase becomes larger. Thus, the rate of growth of productivity in manufacturing will depend positively on the rate of growth of output in manufacturing (called as the Kaldor-Verdoorn law). Secondly, manufacturing sector leads to enhanced productivity growth through its linkages with other manufacturing and non-manufacturing sectors.

 

**1.1. Manufacturing as an Engine of Growth – Arguments:**

The development path as followed by a large number of developed countries is from agriculture to manufacturing to services. The productivity being higher in the manufacturing sector and the sector being more dynamic, the transfer of labour / resources from agriculture to manufacturing would immediately lead to increased productivity (termed as a *structural change bonus*), thereby contributing to growth. Moreover, there exists opportunities for capital accumulation and for embodied and disembodied technological progress which act as an engine of growth (Cornwall, 1977). Capital accumulation can be more conveniently realized in spatially concentrated manufacturing than in spatially dispersed agriculture. Technological advance is concentrated in the manufacturing sector and diffuses from there to other economic sectors such as the service sector. The manufacturing sector also offers important opportunities for economies of scale in large number of key industries like steel, cement, aluminium, paper, glass, chemical, fertilizer etc which are less available in agriculture or services. Incidentally, due to the increasing use of ICTs in service sectors and their inherent characteristic of negligible marginal cost, these economies are no longer restricted to manufacturing.

Linkages in terms of both forward and backward and spillover effects within manufacturing and other sectors are stronger for manufacturing than for agriculture or mining. Increased final demand for manufacturing output will persuade increased demand in many sectors supplying inputs. In addition to these backward linkages, Cornwall (1977) emphasizes that the manufacturing sector also has numerous forward linkages, through its role as a supplier of capital goods (and the new technologies that these goods embody). Lastly, Engel's law states that as per capita incomes rise, the share of agricultural expenditure in total expenditure declines and the share of expenditure on manufactured goods increases. The implication of this is that if countries specialize in agricultural and primary products, they will not gain from expanding world markets for manufacturing goods.

[Insert Table-1 here]

Table 1 shows that annual growth rate of industrial production is gradually increasing in Indian manufacturing over years as Index number of Industrial Production depicts so. Against this background information, this article aims at examining whether growth in industrial output of selected manufacturing industries of our research consideration like –Iron&steel, aluminium, cement, glass, fertilizer, chemical and paper and pulp etc. is as a result of productivity growth or input accumulation.

Results obtained through such an exercise are expected to help identify the character of growth path followed by the manufacturing sector of India in the context of Krugman's thesis. For that purpose, it considers the data of a seven energy intensive industries mentioned above.

Rest of the paper is organised as follows. Section 3 presents methodology and data source, while Section 4 gives empirical results. Major conclusions of the analysis are presented in Section 5.

**3.Methodology and data source:**

*3.1. Econometric model:*

This paper covers a period of 25 years from 1979 -80 to 2003-04.The entire period is sub-divided into two phases as pre-reform period (1979 -80 to 1991-92) and post-reform period (1991-92 to 2003-04).

The partial factor productivity has been estimated by dividing the total output by the quantity of an input. In this paper, TFPG is estimated under three input framework applying translog index of TFP as below: -

$$\Delta \text{Ln TFP}(t) =$$

$$\Delta \text{Ln } Q(t) - \left[\frac{S_L + S_L(t-1)}{2} \times \Delta \text{Ln } L(t)\right] - \left[\frac{S_K(t) + S_K(t-1)}{2} \times \Delta \text{Ln } K(t)\right] - \left[\frac{S_M(t) + S_M(t-1)}{2} \times \Delta \text{Ln} M(t)\right]$$

Q denotes gross output, L Labour, K Capital, M material including energy input.

 

$\Delta$Ln Q(t) = Ln Q(t) – Ln Q(t – 1)

$\Delta$Ln L(t) = Ln L(t) – Ln L(t – 1)

$\Delta$Ln K(t) = Ln K(t) – Ln K(t – 1)

$\Delta$LnM(t) = Ln M(t) – Ln M(t – 1)

$S_K$, $S_L$ and $S_M$ being income share of capital, labor and material respectively and these factors add up to unity. $\Delta$Ln TFP is the rate of technological change or the rate of growth of TFP.

Using the above equation, growth rates of total factor productivity have been computed for each year. These have been used to obtain an index of TFP in the following way. Let Z denote the index of TFP. The index for the base year, Z(0), is taken as 100. The index for the subsequent years is computed using the following equation:

$Z(t) / Z( t-1) = \exp[\Delta LnTFP(t)]$.

The translog index of TFP is a discrete approximation to the Divisia index of technical change. It has the advantage that it does not make rigid assumption about elasticity of substitution between factors of production (as done by Solow index). It allows for variable elasticity of substitution. Another advantage of translog index is that it does not require technological progress to be Hicks-neutral. The translog index provides an estimate of the shift of the production function if the technological change is non-neutral.

After that ,growth of output of those industries under our research consideration has been compared with productivity growth and inputs accumulation to be acquainted with nature of contribution of productivity growth and inputs accumulation in output growth of the industries.

*3.2.Data source:*

The present study is based on industry-level time series data taken from several issues of Annual Survey of Industries, National Accounts Statistics, *CMIE* and Economic survey, Statistical Abstracts (several issues), *RBI* Bulletin on Currency and Finance, Handbook of Statistics on Indian Economy, Whole sale price in India prepared by the Index no of office of Economic Advisor, Ministry of Industry etc covering a period from 1979-80 to 2003-04.

**4. Empirical results regarding Growth in output, employment, partial factor productivity and total factor productivity growth:**

The reforms initiated in 1990s added momentum to enhance the competition, productivity and efficiency. Productivity is a relationship between real output and input; it measures the efficiency with which inputs are transformed into outputs in the production process. Increased productivity is related with more output produced with either the same amount of inputs, or with fewer inputs, or with little increment in inputs. Higher productivity growth is associated with increase in capital intensity, labour productivity and capital productivity and material productivity. Empirical evidence suggests that productivity in turn reduces unit cost; enhance product quality, increase workers wage, and offers returns on investment. Productivity is the prime determinant of a country's level of competitiveness, higher standard of living and sustained growth in the long run. The present section is an attempt to analyze the response of energy intensive industries in India in terms of inputs and output growth as well as in terms of total factor productivity growth to new policy initiatives started in 1991 at aggregate level.

Therefore, in this section, we have tried to measure total factor productivity growth, partial productivity growth in respect of material, labour and capital inputs. Partial productivity indices defined as the real output per unit of any particular real input like labour, material or capital, are the simplest and most intuitive measures of productivity. One point is to be noted in the context of partial productivity analysis is that it tends to depend, to a great extent, on capital intensity.

In cement industry, broad variations in the magnitude of TFPG are found in the estimation. The estimated TFPG of Indian cement sector at the aggregate reveals contradictory rates of TFPG growth (both positive and negative) and it varies over years within the same sector. But, our aggregate

 

analysis also depicts sign of declining trend in average TFP growth rate during post-reform period as compared to pre-reform period. It is evident that the estimated average growth rate of TFP at aggregate level in cement sector for the period 1979-80 to 1991-92 is 1.44 percent p.a whereas post-reform period covering 1991-92 to 2003-04 in our study witnessed a further decreasing growth of 1.013 percent p.a., a noticeable decline from growth rate as in pre-reform period. The trend growth rate of TFP in Indian cement sector is assessed to be -0.0043 percent for the entire period 1979-80 to 2003-04 (estimated from semi-log trend) implying average overall annual deceleration of -0.0043 percent p.a. On the whole, impact of economic reforms on TFPG at aggregate level was adverse as the average rate of TFPG estimated in the pre-reform period furthermore decreased in post-reform period. Moreover, difference between mean TFPG of two periods is statistically significant at 0.05 levels thereby indicating that average TFPG between two periods are statistically different. The estimated TFPG rate at the aggregate level of Indian aluminium industry for the entire period, 1979-80 to 2003-04 reveals paradoxical pictures with positive as well as negative rates. During pre-reforms period (1979-80 to 2003-'04), aluminium sector has recorded a negative growth rate of -0.2008 %. It could be noticed from the average TFPG estimated during the post- reforms period that the reform process yielded negative results on the productivity levels of the aluminium sector because it is visible from the estimated average TFPG that there is a significant drop in the extent of negative TFPG which is -1.43% when compared to that in the pre-reform period. Total factor productivity growth in iron and steel industry displays declining growth rate in post-reforms period compared to pre-reform period. It is evidenced from table 2 that the estimated growth rate of TFP at aggregate level for the period 1979-80 to 1991-92 is 0.5650 percent p.a whereas post-reform period covering 1991-92 to 2003-04 in our study witnessed a declining positive growth of 0.4761 percent p.a., a noticeable downfall from growth rate as shown in pre-reform period. On the whole, impact of economic reforms on TFPG of iron industry at aggregate level was adverse as the average rate of TFPG estimated in the pre-reform period furthermore decreased in post-reform period. Within the same industry, over the years, there exist severe variations in total factor productivity growth. Analysis of the TFPG of Indian chemical industry shows declining growth rate in negative fashion during post- reforms period. The pre-reform era (1979-80 to 1991-92) witnessed a positive growth rate of 0.6525 percent but during post-reforms period (1991-92 to 2003-04), it is estimated to be -0.3231 percent p.a. Moreover, total factor productivity growth shows contradictory positive and negative trends over years within the same industry. Inspection of average TFPG of fertilizer industry in India exhibits an overall negative growth rate in TFP. It is obvious from table 2 that the estimated growth rate of TFP for the period 1979-80 to 1991-92 is 0.44 percent p.a which signifies a positive rate of growth in TFP where as post-reform period covering 1991-92 to 2003-04 in our study witnessed a sharp negative growth of -1.12 percent p.a., a steeper fall from growth rate as revealed in pre-reform period. This decline is due to reduced capacity utilization caused by downfall in production rather than being a consequence of lack of technical progress. The growth rate of TFP in Indian fertilizer sector is assessed to be –0.055 percent p.a. implying average overall annual deceleration for the entire period 1979-80 to 2003-04. On the whole, impact of economic reforms on TFPG at aggregate level was poor as the positive average rate of TFPG estimated in the pre-reform period declined to negative growth in post-reform period. More over, difference between mean TFPG of two periods is statistically significant at 0.05 levels thereby indicating that average TFPG between two periods are statistically different.

In paper and pulp sector, the estimated growth rate of TFP for the period 1979-80 to 1991-92 is 0.64 percent per annum whereas during the post-reform period, 1991-92 to2003-04, TFPG shows slight downward trend which is estimated to be 0.58 percent per-annum but average growth rate for the entire period is significantly negative (-0.014 percent). Moreover, TFPG varies widely among years within the same paper sector. Total factor productivity growth of Indian glass industry during pre-reform period declined in a negative fashion which is posted as -0.09 and in post-liberalization period, it further declined to -0.68.Large variations in the magnitude of TFPG are found in the evaluation. The estimated TFPG of the Indian glass industry at the aggregate level reveals differing rates of productivity growth over years. Over our study period, negative trend in the TFPG is observed at aggregate level.

 

Therefore, overall analysis of average TFPG growth suggests that in all the industries taken up under our study, average TFPG growth depicts declining growth rate during post-reform periods as compared to pre-reform periods.

This does not mean, however, that reforms failed to have a favorable effect on industrial productivity. Rather, some research undertaken recently (Goldar and Kumari, 2003; Topalova, 2004) has shown that trade liberalization did have a positive effect on industrial productivity. The explanation for the slowdown in TFP growth in Indian manufacturing in the post-reform period seems to lie in the adverse influence of certain factors that more than offset the favorable influence of the reforms. Two factors that seem to have had an adverse effect on industrial productivity in the post-reform period are (a) decline in the growth rate of agriculture and (b) deterioration in capacity utilization in the industrial sector (Goldar and Kumari,2003). Uchikawa (2001, 2002) has pointed out that there was an investment boom in Indian industry in the mid-1990s. While the investment boom raised production capacities substantially, demand did not rise which led to capacity under-utilization.Goldar and Kumari (2003) have presented econometric evidence that indicates that the slowdown in TFP growth in Indian manufacturing in the post-reform period is attributable to a large extent to deterioration in capacity utilization.

[Insert Table-2 here]

The table 2 depicts the overall growth rate in value added, capital, employment and partial productivity in energy intensive industries under our study. The picture that emerges for the Indian cement sector is that the overall long-term growth in output (value added) is 7.94 percent per annum in this sector during 1979-80 to 2003-04 which is associated with a rapid growth of capital (10.29 percent per annum) and comparatively a low growth of employment (3.43 percent per annum). Comparing the annual growth rates during 1979-80 to 1991-92 with those of 1991-92 to 2003-04, the post-reform period, it is found that there is a sharp decline in growth rate of value added from 10.49 per cent per annum in pre-reform period to 5.74 per cent per annum in post-reform period. Labour productivity for the whole period increased at an annual rate of 4.88 per cent per annum while capital productivity decreased at a rate of -1.75 per cent per annum. Capital intensity for the entire period is 6.97 per cent per annum. Estimates for the sub-periods reveal differences in the growth rates. Labour productivity decreases at a higher rate, i.e. at a 6.50 per cent per annum in the pre-reform period as against 3.80 per cent per annum in the post-reform period. Capital productivity shows a sign of negative trend in the first period of the analysis and it decreases sharply in the second period. Capital intensity decreases slightly at a 6.51 per cent per annum in the post-reform period as against 7.96 per cent per annum in the pre-reform period. The estimate of total factor productivity (TFP) growth of Indian cement industry is -0.0043 per cent per annum over the entire period, 1979-80 to 2003-04. Total factor productivity growth is lowered down during the post-liberalization period than during the pre- reforms period of the analysis. In iron and steel industry, labour productivity for the whole period shows a growth rate at an annual average of 5.81 percent per annum whereas capital productivity shows an annual average growth rate of 0.80 percent. Capital intensity for the entire period is 5.05 whereas an estimate for the sub-period shows difference in growth rates. Post-reform capital productivity and labour productivity shows increasing trend. Capital intensity increases at higher rate from 4.59 percent in pre-reform period to 5.5 percent in post-reform period. Total factor productivity growth is declining associated with declining growth rate in capital, employment during post-reform period. In a nutshell, for iron and steel sector, post-reform era witnessed declining growth rate in total factor productivity but acceleration in capital intensity as well as capital, material and labour productivity.

Table 2 also shows that overall long-term growth of 6.76 percent in value added (output ) in Indian iron and steel industry during 1979-80 to 2003-04 is associated with rapid growth of capital(6 percent per annum) and low growth of labour(0.82 percent per -annum). Comparing the annual growth rate of pre-reform period (1979-80 to 1991-92) with that of post-reform period, it is evident that there is an increase in the growth rate of value added from 6.29 percent in pre-reform period to 6.90 percent in post-reform period. It is evident that the revival of growth in output in post 90s was not accompanied by adequate generation of employment in iron and steel sector. Several explanations have been cited

 

for that. It is argued that capital-intensive techniques were adopted because of increase in real wage in 1980s and onward. According to Nagaraj (Cited in A.K.Ghosh.1994), the "overhang' of employment that existed in 1970s were intensively used in the 1980s, thus generating only few additional employment opportunities in the latter decades. It has also been argued that labour retrenching technique was difficult after introduction of the job security regulation in the late1970s and this forced the employers to adopt capital-intensive production techniques (Goldar, 2000). Productivity of capital increased from 0.26 to 1.33 along with that of labour productivity, which increased from 4.7 to 7.06 during these two time frames. These changes were reflective of an increase in the rate of growth of capital intensity. The data also shows that the increase in the growth rate of output as is evident from the table 2 is not accompanied by an increase in the productivity.

In aluminium industry**,** labour productivity for the whole period shows a growth rate at an annual average of 1.39 percent per annum whereas capital productivity shows an annual average growth rate of 0.23 percent. Capital intensity for the entire period is 1.16 whereas an estimate for the sub-period shows difference in growth rates. Consequent to economic reforms in July, 1991, capital productivity shows increasing trend but labour productivity reflects dismal declining trend. Capital intensity decreases at higher rate from 3.21 percent in pre-reform period to 1.04 percent in post-reform period. Total factor productivity growth is sharply declined associated with declining growth rate in capital as well as employment during post-reform period. In a nut shell, for aluminium sector, post-reform era witnessed declining growth rate in total factor productivity accompanied by acceleration in capital and material productivity. Overall long-term growth of 6.21 percent in value added (output) in Indian aluminium industry during 1979-80 to 2003-04 is associated with rapid growth of employment (3.82 percent per-annum). It is obvious that there is a decrease in the growth rate of value added from 6.27 percent in pre-reform period to -2.20 percent in post-reform period. The revival of growth in output in post 90s was not possible by adequate generation of employment in aluminium sector. Productivity of capital increased from 2.34 to 7.88 whereas labour productivity declined sharply from 5.10 to 1.89 during these two time frames. These changes were reflective of a decline in the rate of growth of capital intensity.

In paper and pulp industry, productivity of capital decreased from -0.60 to -1.83 along with that of labour productivity, which decreased from 4.71 to 3.02 during these two time frames. These changes were reflective of an increase in the rate of growth of capital intensity. The data also shows that the decrease in the growth rate of productivity as is evident from the table 2 is accompanied by a decrease in the growth rate of output.Labour productivity for the whole period shows a growth rate at an annual average of 4.86 percent per annum whereas capital productivity shows an annual average growth rate of -0.61 percent. Capital intensity for the entire period is 5.47 whereas an estimate for the sub-period shows difference in growth rates. Capital productivity and labour productivity during post-reform era shows simultaneously declining trend. Capital intensity increases slightly in post-reform period. Total factor productivity growth is decelerating with declining growth rate in capital, employment during post-reform period. In brief, for paper sector, post-reform era visualized some kind of declining growth rate in total factor productivity along with acceleration in capital intensity as well as material productivity but value added, employment and capital growth along with capital and labour productivity reflects declining growth rate.

In fertilizer sector, labour productivity for the entire period,1979-80 to 2003-04, shows a growth rate at an annual average of 10.02 percent per annum whereas capital productivity shows a negative annual average growth rate of -1.06 percent. Capital intensity for the entire period is 11.12 whereas an estimate for the sub-period shows difference in growth rates. With the initiation of new policy regime in 1991, capital productivity shows abrupt decreasing trend which turns out to be negative (-5.52 percent) but labour productivity growth displays slightly accelerated growth rate during post reform periods. Capital intensity also decreases from 15.17 percent in pre-reform period to 8.32 percent in post-reform period. Total factor productivity growth is declining associated with declining growth rate in value added, employment, and capital intensity during post-reform period. Therefore, for fertilizer sector, post-reform era is evidenced by declining growth rate in total factor productivity but acceleration in capital growth, material and labour productivity. Overall long-term growth of 8.93 percent in value added (output) in Indian fertilizer industry during 1979-80 to 2003-04 is associated

 

with rapid growth of capital (8.71 percent per annum). Comparing the annual growth rate of pre-reform period (1979-80 to 1991-92) with that of post-reform period, it is evident that there is a decline in the growth rate of value added from 15.33 percent in pre-reform period to 3.74 percent in post-reform period. Productivity of capital decreased from 3.20 to -5.52 but labour productivity increased from 10.13 to 10.21 during these two time frames. These changes were reflective of a decline in the rate of growth of capital intensity. The data also shows that the decrease in the growth rate of output is accompanied by a decrease in the productivity.

In glass sector, labour productivity for the whole period of our study shows a growth rate at an annual average of 6.19 percent per annum and capital productivity shows an annual average growth rate of -3.08 percent . Capital intensity for the entire period is 10.06 whereas an estimate for the sub-period shows difference in growth rates. After economic reforms in July, 1991, capital productivity and labour productivity shows decreasing trend. Capital intensity increases at higher rate from -6.36 percent in pre-reform period to12.52 percent in post-reform period. Total factor productivity growth is declining in negative fashion associated with declining growth rate in capital and employment growth declines during post-reform period. In short, for Glass sector, post-reform era witnessed declining growth rate in total factor productivity, labour and capital productivity but acceleration in capital intensity as well as material productivity. Comparing the annual growth rate of pre-reform period (1979-80 to 1991-92) with that of post-reform period, it is evident that there is a decrease in the growth rate of value added from 10.34 percent in pre-reform period to 4.76 percent in post-reform period showing an average growth rate of 6.19 percent during the entire period. It is evident that the revival of growth in output in post 90s was not possible by adequate generation of employment in Glass sector. Productivity of capital decreased from 2.39 to -5.27 along with that of labour productivity which shows abrupt decline from 1.53 to -0.26 during these two time frames. The data also shows that the decrease in the growth rate of output is also accompanied by a decrease in the productivity.

In chemical industry, labour productivity for the entire period of our study shows a growth rate at an annual average of 7.61 percent per annum whereas capital productivity shows an annual average growth rate of 0.34 percent. Capital intensity for the entire period is 5.58 whereas an estimate for the sub-period shows slight difference in growth rates. Capital productivity and labour productivity shows decreasing trend with the introduction of reforms in 1991. Capital intensity increases very negligibly from 5.52 percent in pre-reform period to 5.50 percent in post-reform period. Total factor productivity growth is declining in negative fashion associated with declining growth rate in value added. In short, for chemical sector, post-reform era witnessed declining growth rate in total factor productivity, labour and capital productivity but acceleration in capital growth as well as material productivity is noticed. There is a decrease in the growth rate of value added from 8.04 percent in pre-reform period to 6.85 percent in post-reform period showing an average growth rate of 7.61 percent during the entire period. The stimulation of growth in output in post 90s was not possible by adequate generation of employment in Glass sector. Productivity of capital decreased from 1.07 to -0.05 along with that of labour productivity which shows abrupt decline from 6.57 to 5.10 during these two time frames. The data also shows that with the decrease in the growth rate of output, total factor productivity decreases.

On the whole, value added in all the industries except iron&steel sector declined sharply during the post-reforms period whereas post-reform period shows that growth in capital investment gradually declined in all the industries except chemical and fertilizer. Growth in employment also declined in all industries except chemical during post-liberalized scenario. Analysis of partial productivity shows that material productivity increases in all the sectors except cement industry, capital productivity declined during post-reform period in all industries except aluminium and iron industry. Post-reform era witnesses declining growth rate of labour in all energy intensive industries except fertilizer and iron&steel industries.

For a very long time, economic theory highlighted capital and labour, the two primary factors of production, as the key driving force behind production and growth. It was only in the 1950s that technological advancement as an important source of growth was brought into the discussion of mainstream economic theory. Solow's (1957) pioneering attempt to estimate the contribution of physical factors to growth, by introducing the technique of growth accounting, revealed that only 1/8th of the growth of the US economy during the first half of the present century could be explained by the

 

growth of its endowments of physical factors, leaving the remaining to a "residual" (termed as technical progress or total factor productivity growth (TFPG)). Focus shifted thereafter from physical factors to the role of technology in production and growth. It is fairly well established now that technological advancement resulting from R&D is the most important factor behind today's productivity growth. Indeed, the growth experience of most advanced industrial nations has been driven by TFPG rather than by growth in factor endowments. For these nations, operating essentially on the frontiers of global technology, TFP growth necessarily implies an outward shift of the technological frontier. Of course, the contribution of TFPG to their economic growth has not been uniform across all industrialized nations. Hayami (1999), for instance, compared the sources growth in Japan and the USA during their respective high growth periods (1958-70 for Japan and 1929-66 for the USA) and found, not surprisingly, that Japan's growth was attributable to both capital input growth as well as technical progress as opposed to the US experience of predominantly technology driven growth – TFP contribution being 53 per cent for Japan's growth and 80 per cent for the USA. Even, for the late industrializing countries in East Asia (the so-called East Asian Tigers: South Korea, Hong Kong, Singapore and Taiwan), the contribution of TFP has been observed to be much more moderate than the US experience. According to World Bank (1993), approximately two-thirds of the observed growth in these economies may be attributed to accumulation of physical and human capital and the rest came from total factor productivity growth. This is not to deny that productivity growth did play a very important role in East Asian success, but it was clearly not the sole (and not even the dominant) factor.

With the prediction of non-sustainability of growth registered by the East Asian countries, Krugman's thesis [Krugman 1994] leaves an implicit appeal for most of the developing economies to examine their positions. In a situation of fragile total factor productivity growth (TFPG), a syndrome which most of the developing countries encounter, it becomes imperative to undertake an analysis of growth decomposition

of output in Indian manufacturing industries to identify its major contributing factors. Such a result is likely to help provide appropriate policy guidelines while projecting the long-run growth trajectory of the countries.

Theoretically, sources of economic growth are composed of factor accumulation and productivity growth. The first source may lead to high growth rates, but only for a limited period of time. Thereafter, the law of diminishing returns inevitably occurs. Consequently, sustained growth can only be achieved through productivity growth, that is, the ability to produce more and more output with the same amount of input. Some researchers argued that the Soviet Union of the 1950s and the 1960s, and the growth of the Asian 'Tigers' are as examples of growth through factor accumulation (e.g. Krugman, 1994). On the other hand, growth in the industrialized countries appears to be as the result of improved productivity (e.g. Fare et *al*, 1994).

Therefore, a major focus of the present study is to analyze the contribution of inputs and TFPG to output growth. On the basis of the methodology outlined earlier, source specific growth of output is reported in Table 3.

[Insert Table-3 here]

Traditionally (owing to Solow), the sources of output growth are decomposed into two components: a component that is accounted for by the increase in factors of production and a component that is not accounted for by the increase in factors of production which is the residual after calculating the first component. The latter component actually represents the contribution of TFP growth.

Therefore, the pertinent question of whether output growths of these industries are the result of factor accumulation or productivity-driven has been tested for these energy intensive industries. Table 4 shows the relative contribution of TFP growth and factor input growth for the growth of output during

 

1979-80 to 2003-04. Observing the growth path, it is apparent that in all the industries under our study, TFP growth contribution is either negative or negligible and insignificant across the entire time frame. Therefore, it is true that increase in factor input is responsible for observed output growth and TFP contribution plays negligible role in enhancing output growth. Therefore, output growth in energy intensive industries in India was fundamentally dominated by accumulation of factors resulting input-driven growth and TFP has a negligible or negative contribution to output growth.

**5. Summary and Conclusions:**

The present exercise attempts to examine the contribution of inputs and total factor productivity growth to the growth of output by considering the aggregate manufacturing sector and seven selected manufacturing industries of India during the period 1979-80 to 2003-04. Major findings of the study indicate that output growth in the selected Indian manufacturing industrial sectors is driven mainly by inputs accumulation while the contribution of TFP remains either minimal or negative. The growth rate of total factor productivity in almost all the industries under our study is gradually declining, especially during the post-reforms period. Therefore, manufacturing sector, being input driven output growth sector of India, does not remain outside the purview of the sustainability issue raised by Krugman.

The pattern of sources of output growth with respect to source of productivity growth and input accumulation remains unchanged during two periods but the relative contribution of each source of growth to output growth from pre-liberalisation to post-liberalisation period has increased for some other industries but has decreased for some other industries. On the other hand, for some of the industries the relative contribution has changed from positive during pre-liberalisation period to negative during post-liberalisation period or from negative during pre-liberalisation period to positive during post-liberalisation period. The change in pattern of sources of output growth may have taken place due to liberalization policies and structural reforms undertaken during the 1990s.

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**Table:1:Annual Growth rate of Industrial Production**

| Period | Index of Industrial Production(IPP) (Base:1993-94) | Annual Growth rate(%) |
|---|---|---|
| 1998-99 | 145.2 | 4.1 |
| 1999-2000 | 154.9 | 6.7 |
| 2000-01 | 162.6 | 5.0 |
| 2001-02 | 167.0 | 2.7 |
| 2002-03 | 176.6 | 5.7 |
| 2003-04 | 189.0 | 7.0 |
| 2004-05 | 204.8 | 8.4 |
| 2005-06 | 221.5 | 8.2 |
| 2006-07 | 247.0 | 11.5 |

**Source: Statistical Abstract,2007-08.**

**Table: 2: Growth rate of value added, capital, employment and partial factor productivity etc. in selected manufacturing industries in India (%)**

| Industry | Year/Growth rate | Value added | Capital | Employment | Material productivity | Capital productivity | Labour Productivity | Capital intensity | Total factor productivity growth |
|---|---|---|---|---|---|---|---|---|---|
| Cement | 1979-‘80 to 2003-‘04 | 7.94 **(7.78)** | 10.29 **(6.05)** | 3.43 **(0.65)** | 2.93 **(1.49)** | -1.75 **(1.64)** | 4.88 **(7.09)** | 6.97 **(5.36)** | -0.0043 **(1.24)** |
| | 1979-‘80 to 1991-‘92 | 10.49 **(6.67)** | 11.97 **(4.34)** | 4.15 **(0.23)** | 4.66 **(1.23)** | -1.42 **(2.23)** | 6.5 **(6.43)** | 7.96 **(4.11)** | 1.44 **(1.53)** |
| | 1991-‘92 to2003-‘04 | 5.74 **(4.38)** | 8.66 **(4.63)** | 2.26 **(-0.81)** | 0.71 **(1.61)** | -2.08 **(-0.23)** | 3.80 **(5.24)** | 6.51 **(5.48)** | 1.013 **(0.44)** |
| Aluminium | 1979-‘80 to 2003-‘04 | 5.21 **(7.78)** | 4.98 **(6.05)** | 3.82 **(0.65)** | 2.39 **(1.49)** | 0.23 **(1.64)** | 1.39 **(7.09)** | 1.16 **(5.36)** | 0.0011 **(1.24)** |
| | 1979-‘80 to 1991-‘92 | 6.27 **(6.67)** | 4.99 **(4.34)** | 2.69 **(0.23)** | -0.48 **(1.23)** | 2.34 **(2.23)** | 5.10 **(6.43)** | 3.21 **(4.11)** | -0.2008 **(1.53)** |
| | 1991-‘92 to2003-‘04 | -2.20 **(4.38)** | 0.60 **(4.63)** | 2.09 **(-0.81)** | 4.45 **(1.61)** | 7.88 **(-0.23)** | 1.89 **(5.24)** | 1.04 **(5.48)** | -1.43 **(0.44)** |
| Iron&steel | 1979-‘80 to 2003-‘04 | 6.76 **(7.78)** | 6.00 **(6.05)** | 0.82 **(0.65)** | 1.83 **(1.49)** | 0.80 **(1.64)** | 5.81 **(7.09)** | 5.05 **(5.36)** | -0.13 **(1.24)** |
| | 1979-‘80 to 1991-‘92 | 6.29 **(6.67)** | 6.18 **(4.34)** | 0.93 **(0.23)** | 1.39 **(1.23)** | 0.26 **(2.23)** | 4.7 **(6.43)** | 4.59 **(4.11)** | 0.5650 **(1.53)** |
| | 1991-‘92 to2003-‘04 | 6.90 **(4.38)** | 5.67 **(4.63)** | 0.59 **(-0.81)** | 1.76 **(1.61)** | 1.33 **(-0.23)** | 7.06 **(5.24)** | 5.50 **(5.48)** | 0.4761 **(0.44)** |
| Chemical | 1979-‘80 to 2003-‘04 | 7.61 **(7.78)** | 7.33 **(6.05)** | 1.81 **(0.65)** | 3.07 **(1.49)** | 0.34 **(1.64)** | 5.71 **(7.09)** | 5.58 **(5.36)** | -0.07 **(1.24)** |
| | 1979-‘80 to | 8.04 | 6.94 | 1.47 | 1.67 | 1.07 | 6.57 | 5.52 | 0.65 |

 

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1991-‘92 | **(6.67)** | **(4.34)** | **(0.23)** | **(1.23)** | **(2.23)** | **(6.43)** | **(4.11)** | **(1.53)** |
| | 1991-‘92 to2003-‘04 | 6.85 | 7.84 | 2.39 | 4.59 | -0.05 | 5.10 | 5.50 | -0.32 |
| | | **(4.38)** | **(4.63)** | **(-0.81)** | **(1.61)** | **(-0.23)** | **(5.24)** | **(5.48)** | **(0.44)** |
| Fertilizer | 1979-‘80 to 2003-‘04 | 8.93 | 8.71 | 2.23 | 2.55 | -1.06 | 10.02 | 11.12 | -0.05 |
| | | **(7.78)** | **(6.05)** | **(0.65)** | **(1.49)** | **(1.64)** | **(7.09)** | **(5.36)** | **(1.24)** |
| | 1979-‘80 to 1991-‘92 | 15.33 | 8.79 | 6.61 | 1.90 | 3.20 | 10.13 | 15.17 | 0.44 |
| | | **(6.67)** | **(4.34)** | **(0.23)** | **(1.23)** | **(2.23)** | **(6.43)** | **(4.11)** | **(1.53)** |
| | 1991-‘92 to2003-‘04 | 3.74 | 10.14 | -1.67 | 2.70 | -5.52 | 10.21 | 8.32 | -1.12 |
| | | **(4.38)** | **(4.63)** | **(-0.81)** | **(1.61)** | **(-0.23)** | **(5.24)** | **(5.48)** | **(0.44)** |
| Paper&pulp | 1979-‘80 to 2003-‘04 | 6.47 | 7.08 | 1.62 | 2.12 | -0.61 | 4.86 | -0.14 | -0.002 |
| | | **(7.78)** | **(6.05)** | **(0.65)** | **(1.49)** | **(1.64)** | **(7.09)** | **(1.24)** | **(1.24)** |
| | 1979-‘80 to 1991-‘92 | 7.79 | 7.38 | 1.70 | 2.28 | -0.60 | 4.71 | 0.64 | 0.64 |
| | | **(6.67)** | **(4.34)** | **(0.23)** | **(1.23)** | **(2.23)** | **(6.43)** | **(1.53)** | **(1.53)** |
| | 1991-‘92 to2003-‘04 | 4.50 | 6.58 | 1.21 | 2.48 | -1.83 | 3.02 | 0.94 | 0.58 |
| | | **(4.38)** | **(4.63)** | **(-0.81)** | **(1.61)** | **(-0.23)** | **(5.24)** | **(0.44)** | **(0.44)** |
| Glass | 1979-‘80 to 2003-‘04 | 6.19 | 9.52 | -0.32 | 1.52 | -3.08 | 7.18 | 10.06 | -0.104 |
| | | **(7.78)** | **(6.05)** | **(0.65)** | **(1.49)** | **(1.64)** | **(7.09)** | **(5.36)** | **(1.24)** |
| | 1979-‘80 to 1991-‘92 | 10.34 | 0.23 | 1.53 | -0.50 | 2.39 | 8.92 | 6.36 | -0.09 |
| | | **(6.67)** | **(4.34)** | **(0.23)** | **(1.23)** | **(2.23)** | **(6.43)** | **(4.11)** | **(1.53)** |
| | 1991-‘92 to2003-‘04 | 4.76 | 0.09 | -0.26 | 2.80 | -5.27 | 5.30 | 12.52 | -0.68 |
| | | **(4.38)** | **(4.63)** | **(-0.81)** | **(1.61)** | **(-0.23)** | **(5.24)** | **(5.48)** | **(0.44)** |

**# Growth rates for the entire period are obtained from semi-log trend.**

**# # Figures in the parenthesis indicate growth rates of respective parameters in aggregate manufacturing.**

**Source: Own estimate.**

**Table -3: Contribution of TFPG to output growth under liberalized trade regime**

| Industry | Contribution of TFPG and inputs to output growth | Phase 1 (1979-‘80 to ‘85-‘86) | Phase 2 (1986-‘87 to ‘91-‘92) | Phase 3 (1992-‘93 to ‘97-‘98) | Phase 4 (1998-‘99 to2003-04) | Pre-reform period (1979-‘80 to 1991-‘92) | Post-reform period (1991-‘92 to 2003-‘04) | Entire period (1979-‘80 to03-‘04) |
|---|---|---|---|---|---|---|---|---|
| Cement | Output growth | 11.05 | 9.93 | 6.03 | 4.75 | 10.49 | 5.74 | 7.94 |
| | Contribution of Input growth | 10.05 (95.02%) | 8.74 (88.02%) | 5.12 (84.91%) | 5.29 (111.37%) | 9.62 (91.71%) | 4.73 (82.35%) | 7.944 (100.054%) |
| | Contribution of TFPG | 0.55 (4.98%) | 1.19 (11.98%) | 0.91 (15.09%) | -0.54 (-11.37%) | 0.87 (8.29%) | 1.013 (17.65%) | -0.0043 (-0.054%) |
| Aluminium | Output growth | 5.89 | 6.65 | -3.66 | -1.23 | 6.27 | -2.20 | 5.21 |

 

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Contribution of Input growth | 3.09 (52.46 %) | 10.19 (153.23%) | -5.41 (-147.81%) | -0.18 (-14.63%) | 6.64 (105.9%) | -2.23 (-101.36%) | 5.32 (102.11%) |
| | Contribution of TFPG | 2.80 (47.53%) | -3.54 (-53.23%) | 1.75 (47.81%) | -1.05 (-85.37%) | -0.37 (-5.90%) | 0.03 (1.36%) | -0.11 (-2.11%) |
| Iron&steel | Output growth | 4.43 | 7.33 | 7.79 | 6.91 | 6.29 | 6.9 | 6.76 |
| | Contribution of Input growth | 3.69 (83.21%) | 6.51 (88.81%) | 7.09 (90.98%) | 6.2 (89.67%) | 5.72 (91.02%) | 6.42 (93.1%) | 6.89 (101.92%) |
| | Contribution of TFPG | 0.74 (16.79%) | 0.82 (11.19%) | 0.70 (9.02%) | 0.71 (10.33%) | 0.57 (8.98%) | 0.48 (6.90%) | -0.13 (-1.92%) |
| Chemical | Output growth | 7.29 | 8.06 | 9.15 | 5.20 | 8.04 | 7.68 | 7.61 |
| | Contribution of Input growth | 7.64 (104.80%) | 6.4 (79.40%) | 11.04 (111.59%) | 5.74 (110.38%) | 7.39 (91.92%) | 8.0 (104.17%) | 7.68 (100.92%) |
| | Contribution of TFPG | -0.35 (-4.80%) | 1.66 (20.60%) | -1.06 (-11.59%) | -0.54 (-10.38%) | 0.65 (8.08%) | -0.32 (-4.17%) | -0.07 (-0.92%) |
| Fertilizer | Output growth | 3.67 | 26.99 | 7.09 | -2.05 | 15.33 | 3.74 | 8.93 |
| | Contribution of Input growth | 3.95 (107.63%) | 25.82 (95.66%) | 7.43 (100.46%) | -1.30 (63.41%) | 14.89 (97.13%) | 4.86 (127.08%) | 8.98 (127.63%) |
| | Contribution of TFPG | -0.28 (-7.63%) | 1.17 (4.34%) | -0.34 (-0.46%) | -0.75 (36.59%) | 0.44 (2.87%) | -1.12 (-27.08%) | -0.05 (-27.63%) |
| Paper&pulp | Output growth | 6.38 | 9.40 | 5.70 | 2.72 | 7.79 | 4.5 | 6.47 |
| | Contribution of Input growth | 4.67 (73.2%) | 9.83 (104.58%) | 5.55 (97.37%) | 3.43 (100.71%) | 7.15 (91.78%) | 3.56 (79.11%) | 6.472 (100.03%) |
| | Contribution of TFPG | 1.71 (26.80) | -0.43 (-4.58) | 0.15 (2.63) | -0.71 (-26.10) | 0.64 (8.22%) | 0.94 (20.89%) | -0.002 (-0.03%) |
| Glass | Output growth | 7.92 | 12.77 | 2.62 | 2.86 | 10.34 | 4.76 | 6.19 |
| | Contribution of Input growth | 8.38 (105.81%) | 12.48 (97.73%) | 1.86 (70.99%) | 2.25 (78.67%) | 10.43 (100.87%) | 5.44 (114.29%) | 6.29 (101.62%) |
| | Contribution of TFPG | -0.46 (-5.81%) | 0.29 (2.27%) | 0.76 (29.01%) | 0.61 (21.33%) | -0.09 (0.87 %) | -0.68 (-14.29%) | -0.10 (-1.62%) |

**Source: Own estimate**