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PRODUCTIVITY TRENDS IN INDIAN MANUFACTURING IN THE PRE- AND POST-REFORM PERIODS

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Content

Foreword

The growth of GDP during the nineties from manufacturing and from industry has not been accompanied by commensurate growth in manufacturing / industrial employment. The conventional wisdom is that the nineties are characterized by "jobless growth". Research done by the IDBI / IFCI Professor at ICRIER has shown that much of this perception is due to a generally unnoticed change in ASI data at the end of the nineties. Up to 1997-98 ASI industry data contained both manufacturing and other sectors like electricity, gas and water, non-conventional energy, cold storages and repair services. From 1998-1999 the ASI industry data did not contain the Electricity, gas and water sector. Anybody using the industry series till date will, discover that employment growth (the spurious fact) has collapsed during 1998-99 to 2002-03. This paper (appendix) shows that the correct picture is that registered manufacturing employment grew between 1989-90 and 2002-03, but the pattern has an inverted U shape.

The main focus of the paper is however on Total Factor Productivity in (registered) manufacturing. It shows that the conclusions of a recent much quoted study by the IMF and another widely reported one by an industry institute are not correct. One of the important results in this paper is to show that the declining share of wages in registered manufacturing is due to a decline (rise) in the relative marginal productivity of labour (capital). Whether this is because the newly available and more productive technologies are capital biased or is driven by labour policy distortions needs to be explored in future research. The conondrum of lower average TFPG in registered manufacturing during the nineties relative to that in the eighties remains. Our earlier hypothesis that it is due either to lower capacity utilisation since the 1994-5 to 1996-97 investment boom (till 2003-04) or the change in relative prices within manufactured goods as a result of reduced variance in (QR/Tariff) protection also remains to be tested. It should be noted however that ICRIER Working Paper No. 131 has estimated that TFPG in the manufacturing sector as a whole doubled from 1.3% per annum during 1980-81 to 1991-92 to 2.8% per annum during 1992-93 to 2003-04. This implies either a sharp acceleration of TFPG in the unregistered manufacturing sector or outsourcing of inefficient stages of production (or shifts of products) from registered to unregistered manufacturing.

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(Arvind Virmani)
Director & Chief Executive
ICRIER

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Productivity Trends in Indian Manufacturing in the Pre- and Post-Reform Periods

Bishwanath Goldar*

Abstract

Contradicting the findings of several earlier studies, a recent study on productivity trends in Indian manufacturing by Unel (2003) has concluded that total factor productivity (TFP) growth in Indian manufacturing accelerated after the 1991 economic reforms. A relatively faster growth in TFP in Indian manufacturing in the post-reform period as compared to the pre-reform period has been reported also in a study undertaken recently by the Tata Services Limited (TSL) (2003). A close look at the methodology adopted in these two studies, however, reveals certain shortcomings, raising doubts about the reliability of findings. The paper presents an alternative set of estimates of TFP growth in Indian manufacturing in the last two decades, which have been made following by and large the methodology of input and output measurement adopted in the studies of Unel and TSL, but avoiding the methodological inadequacies noticed in these studies. The estimates indicate a slowdown in TFP growth in Indian manufacturing in the post-reform period, and thus do not bear out the findings of the studies by Unel and TSL.

To supplement the analysis of productivity trends in the pre- and post-reform periods, the paper takes a close look at growth in employment and output in India's organized manufacturing sector in the period since the mid-1990s. The analysis reveals that the trend rate of growth in employment in the period 1997-98 to 2001-02 was significantly negative, at about –3.3 per cent per annum. The trend growth rate in real value added in the period 1996-97 to 2001-02 was very low at about 0.5 per cent per annum. This was much lower than the trend growth rates in real value of output and the Index Number of Industrial Production (manufacturing) in this period, both exceeding 5 per cent per annum.

Key Words: Total factor productivity, economic reforms, Indian manufacturing

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1. Introduction

A recent study on productivity trends in Indian manufacturing undertaken by Unel (2003) has concluded that total factor productivity (TFP) growth in aggregate manufacturing and many sub-sectors *accelerated* after the 1991 reforms.[1] Unel's estimate of average annual growth rate in TFP in aggregate manufacturing is 1.8 per cent per annum for the period 1979-80 to 1990-91 and 2.5 per cent per annum for the period 1991-92 to 1997-98.[2] The estimate is based on the value-added function framework, taking value added as output, and labor and capital as inputs.[3] The income shares of labor and capital are used as weights for computing the growth rate of TFP. Unel has presented a second estimate of TFP growth, made by assuming the elasticity of output (value added) with respect to labor to be 0.6 rather than taking the elasticity to be equal to the income share of labor. According to this estimate, the average annual growth rate in TFP in Indian manufacturing was 3.2 per cent during 1979-80 to 1990-91 and 4.7 per cent during 1991-92 to 1997-98. Both estimates indicate acceleration in TFP growth rate in Indian manufacturing in the post-reform period as compared to the pre-reform period.

A relatively faster growth in TFP in Indian manufacturing in the post-reform period as compared to the pre-reform period has been reported also in a study undertaken recently by the Tata Services Limited (TSL), Department of Economics and Statistics (2003) (hereafter referred to as the TSL study). In the TSL study, TFP estimates have

[1] Since 1991, India has undertaken major economic reforms. Significant and far-reaching changes have been made in industrial and trade policy. Import liberalization has been a principal component of the economic reforms undertaken. Tariff rates have been brought down considerably and quantitative restrictions on imports of manufactured products have been by and large removed. For a discussion on India's economic reforms since 1991, see Joshi and Little (1996), among others.

[2] It should be pointed out that Unel's study, as also most other studies on productivity growth in Indian industries, relates to organized manufacturing which covers factories employing 10 or more workers with power or 20 or more workers without power. This is also referred to as registered manufacturing. The discussion of productivity estimates and the analysis presented in the paper relate only to this segment of Indian industry.

[3] For discussion on methodological issues in TFP measurement, see Rao (1996), Balakrishnan and Pushpangadan (1998), OECD (2001) and Goldar and Mitra (2002), among others.

been made for the manufacturing sector (organized) for the period 1981-82 to 1999-00.[4] Estimation of TFP growth has been done by using the gross output function framework, rather than the value-added function framework.[5] The estimated average annual growth rate of TFP in manufacturing is 0.68 per cent for the pre-reform period (taken as 1981-82 to 1992-93) and 0.97 per cent for the post-reform period (1993-94 to 1999-00), lending support to the findings of Unel (2003).

It should be pointed out here that the finding of an acceleration in TFP growth in Indian manufacturing in the post-reform period in the studies of Unel (2003) and TSL (2003) is at variance with the findings of several other studies on productivity growth in Indian manufacturing. The estimates of TFP reported in the studies of Trivedi *et al*. (2000), Goldar (2000) and Goldar and Kumari (2003) indicate a fall in the growth rate of TFP in Indian manufacturing in the post-reform period.[6] Goldar and Kumari, for instance, report that the trend growth rate in TFP in Indian manufacturing (based on the gross output function framework) came down from 1.89 per cent per annum during the period 1981-82 to 1990-91 to 0.69 per cent per annum during the period 1990-91 to 1997-98.[7] A slowdown in TFP growth in Indian manufacturing industries in the post-reform period is indicated also by the analyses of productivity growth in Indian manufacturing industries undertaken by Balakrishnan *et al*. (2000) and Srivastava *et al*. (2001).[8] Clearly, the findings of the studies of Unel and TSL are in disagreement with the findings of several other studies on TFP growth in Indian manufacturing. This calls for a close look at the methodology adopted in the studies of Unel and TSL, to understand what could have caused the differences in findings.

[4] The study presents TFP estimates also for the private corporate manufacturing sector and major Tata group companies. These estimates are not discussed here as the present paper focuses on productivity trends in aggregate organized manufacturing.

[5] For a discussion on the advantages of the gross output function framework over the value added function framework for the estimation of TFP, see Rao (1996), among others.

[6] See Goldar (2002) in this context.

[7] Goldar and Kumari (2003) note that with corrections made for changes in capacity utilization, the estimated trend growth rate of TFP in organized manufacturing for the post-reform period (1.3 per cent per annum) is about the same as that for the pre-reform period (1.6 per cent per annum).

[8] See also Das (2003) whose estimates of TFP growth in Indian industries in the 1980s and 1990s are more in line with the estimates of Trivedi et al. (2000), Goldar (2000) and Goldar and Kuamari (2003) than with the estimates of Unel (2003) and TSL (2003).

The rest of the paper is organized as follows. Section 2 discusses how output and inputs have been measured in the studies undertaken by Unel and TSL, and notes certain methodological inadequacies in input measurement. Section 3 presents an alternative set of estimates of TFP growth in Indian manufacturing in the last two decades, which have been made following by and large the methodology adopted in the studies by Unel and TSL but avoiding the methodological inadequacies noticed in these studies. These TFP estimates indicate a slowdown in TFP growth in Indian manufacturing in the post-reform period, and thus do not bear out the findings of the studies of Unel and TSL. Section 4 addresses the issue of divergence between labor's income share and the elasticity of output with respect to labor, a point raised by Unel in the context of TFP measurement for Indian manufacturing. The final section of the paper, Section 5, summarizes and concludes.

The paper has three annexes. Annex A gives the output and input series for Indian manufacturing that have been constructed and used for the alternative set of estimates of TFP growth presented in Section 3. Annex B describes briefly the Translog index of TFP, which has been used for making the estimates of TFP growth presented in Section 3. Annex C takes a look at growth in employment and output in India's organized manufacturing sector in the period since the mid-1990s.

2. Output and Input Measurement in the Studies by Unel and Tata Services Ltd

2.1 Unel's study

The basic data source of Unel's study is the *Annual Survey of Industries* (ASI) brought out by the Central Statistical Organization (CSO), Government of India, which has been the basic data source of most other studies on productivity in Indian industries. Using ASI data, real output and input series have been constructed for aggregate manufacturing for the period 1979-80 to 1997-98. Rates of TFP growth have been computed for the sub-periods, 1979-80 to 1990-91 (pre-reform period) and 1991-92 to 1997-98 (post-reform period), and for the year 1991-92 over the previous year.

Unel has used the value-added function framework for TFP estimation. Deflated value added has been taken as the measure of output. Deflation has been done by the wholesale price index for manufactured products. Number of workers has been taken as the measure of labor input. Net fixed capital stock at constant prices has been taken as the measure of capital input. The net fixed capital stock series has been constructed from the series on gross fixed capital formation (at constant prices) using the Perpetual Inventory method. The annual rate of depreciation of fixed assets has been taken as 5 per cent.

The starting year of the series on gross fixed capital formation used by Unel is 1970-71. Thus, for computing net fixed capital stock for 1979-80, the base year of the study, the real fixed investment series for the previous 10 years has been used. This appears to have caused a significant underestimation of capital input for the base year of the study, affecting thereby the estimate of growth rate of capital input and hence of TFP.

To explain this point further, let us consider the estimates of net fixed capital stock and gross fixed capital formation in registered manufacturing given in the *National Accounts Statistics* (NAS). According to NAS, net fixed capital stock in registered manufacturing in 1979-80 at current prices was Rs 330.8 billion. Gross fixed capital formation (expressed at 1979-80 prices) in the years 1970-71 to 1979-80, adjusted for 5% annual depreciation and then aggregated, comes to Rs. 211.1 billion, which is only 64 per cent of the net capital stock exiting in 1979-80. If the fixed investment series is taken for the period 1959-60 to 1979-80 (at 1979-80 prices), the aggregation of investment after adjustment for annual 5% deprecation comes to Rs. 315.6 billion which is about 95 per cent of the existing net capital stock. Arguably, Unel has not used a long enough investment series prior to base year to get a good estimate of base year capital stock.

2.2 TSL Study

The basic data source for the TSL study is the same as that used in the study by Unel. The period covered is, however, different. The ASI results for 1998-99 and 1999-00 have been used in the TSL study (thus covering more recent years), which have not been used by Unel.

Another important difference between the two studies relates to the partitioning of the period under study into pre- and post-reform sub-periods. While making comparison of productivity growth performance between the pre- and post-reform periods, Unel has excluded TFP growth in 1991-92 (over the previous year) from both periods. In the TSL study, by contrast, TFP growth in 1991-92 and 1992-93 has been taken as a part of the productivity growth performance in the pre-reform period. Since 1991-92 was a crisis year in which there was a fall in industrial productivity, there is justification for excluding that year from both pre- and post-reform period for making a comparison of productivity growth performance. But, to include 1991-92 and 1992-93 in the pre-reform period, as done by the TSL study, does not seem justified. Rather than including 1991-92 and 1992-93 in the pre-reform period, it perhaps would have been better to leave out these two years from both the pre-reform and post-reform periods while making inter-period comparison of TFP growth rates.

In the TSL study, the estimates of TFP growth are based on the gross output function framework. Value of gross output deflated by the wholesale price index for manufactured products has been taken as the measure of output. Three inputs have been considered: labor, capital and intermediate input. Number of employees has been taken as the measure of labor input. Net fixed capital stock at constant prices has been taken as the measure of capital input. Expenditure on materials, power and fuel (including other energy inputs such as coal) deflated by the wholesale price index for manufactured products has been taken as the measure of intermediate input.

The aggregate factory sector results[9] of the ASI have been used in the TSL study to construct time series on output and inputs. The data for aggregate factory sector for 1998-99 and 1999-00 have been used along with such data for earlier years without making any adjustment for differences in industrial coverage. This has given rise to a problem of data incomparability, affecting the estimates of TFP growth for the post-reform period. It may be pointed out here that the ASI results for 1998-99 and 1999-00 do not cover power generation, transmission and distribution (two-digit industry code 40 according to the National Industrial Classification, 1987) whereas this industry is included in the data for earlier years. This explains why the employment series reported in Appendix II of the TSL study shows a sharp fall in the number of employees in the aggregate factory sector from about 10 million in 1997-98 to 8.17 million in 1999-00, i.e. a fall in employment by about two million persons. If two-digit industry number 40 is excluded from the aggregate ASI data for 1997-98 and a comparison is made with the ASI results for 1999-00, the fall in employment is found to be much lower at about 0.7 million (this is discussed further in Annex C).

The measure of intermediate input used in the TSL study has some notable shortcomings. First, while making an estimate of real value of intermediate inputs used by manufacturing, the study does not take into account the fact that besides materials, power and fuel, the manufacturing units use other intermediate inputs.[10] In particular, it may be noted that the real value of services purchased by industrial units has grown rapidly in the 1990s (Banga and Goldar, 2004). Since deflated value of materials, power and fuel are used to measure intermediate input, and services are excluded, this has led to an underestimation of the growth rate of intermediate inputs in the post-reform period, affecting the TFP estimates.[11] Secondly, the expenditure on materials, power and fuel

[9] Manufacturing constitutes the dominant part of aggregate factory sector covered by the ASI. In 1997-98, for instance, manufacturing accounted for about 85 per cent of total employment in the factory sector.

[10] According to the definition of "total input" in the ASI, it include, besides the cost of material, power and fuel, the following cost items: (a) cost of contract and commission work done by others on materials supplied by the factory, (b) cost of materials consumed for repair and maintenance of factory's fixed assets including cost of repair and maintenance work done by others to the factory's fixed assets, and (c) inward freight and transport charges, postage and telephone charges, insurance charges, banking charges, etc.

[11] Out of the total cost of intermediate inputs, the share of intermediate inputs other than materials, power and fuel (may be assumed to be services mostly) was about 9 per cent by the end of the 1980s. It reached about 18 per cent by the end of the 1990s.

has been deflated by the price index for manufactured products. Thus, the price index used for deflating the value of materials and energy inputs is the same as that used for deflating gross output. This can be questioned. There has been a good deal of discussion on how differences in the growth rates of prices of output and intermediate input can distort TFP measured by the single deflation method (see Rao, 1996; Balakrishnan and Pushpangadan, 1998). This methodological issue in TFP measurement appears to have been overlooked in the TSL study while deciding on the deflator to be used for materials and energy input.

3. Alternative TFP Estimates for Indian Manufacturing

This section presents an alternative set of estimates of TFP growth in Indian manufacturing in the last two decades (hereafter referred to as alternate TFP estimates) which have been made following by and large the methodology adopted in the studies of Unel and TSL but avoiding the methodological inadequacies noticed in these studies. Section 3.1 discusses briefly how output and inputs have been measured (the output-input series are shown in Annex A). The estimates of TFP growth for the pre-reform and post-reform periods are presented in Section 3.2.

3.1 Measurement of Output and Inputs

The basic source of data for the alternate TFP estimates is the *Annual Survey of Industries* (ASI) as in the studies of Unel and TSL. The *Economic and Political Weekly* has created a systematic, electronic database using ASI results for the period 1973-74 to 1997-98. Concordance has been worked out between the industrial classifications used till 1988-89 and that used thereafter (NIC-1970 and NIC-1987), and comparable series for various three- and two-digit industries have been prepared. Comparable data could be obtained for 1998-99 and 1999-00 from a special tabulation of ASI data according to NIC-1987, which was done by the Central Statistical Organization (Government of India) and made available to the ICRIER for a study on trade protection and its impact on industrial productivity (Das, 2003). From these databases, the series on output and input

(undeflated) have been obtained for various two-digit industries, from 20-21 to 39, and then these have been added to form the series for aggregate manufacturing. Data have been drawn on the following variables: gross output, net value added, employment, total emoluments of employees, fixed capital stock, depreciation, and value of intermediate inputs (separate series constructed for materials, power and fuel, and other intermediate inputs).

Real gross output and real gross value added have been obtained by deflating the nominal figures by the wholesale price index for manufactured products (base 1981-82). Total number of persons engaged has been taken as the measure of labor input. This includes working proprietors.

Net fixed capital stock at constant prices has been taken as the measure of capital input. The construction of the net fixed capital stock series has been done by the Perpetual Inventory method. The steps in the construction of fixed capital series are as follows. (1) Implicit deflator for gross fixed capital formation for registered manufacturing is derived from the data on gross fixed capital formation in registered manufacturing at current and constant prices given in the *National Accounts Statistics* (NAS). The deflator series is constructed for the period 1959-60 to 1999-00. The base is shifted to 1981-82 so as to be consistent with the price series used for intermediate inputs and output. (2) From ASI data, gross investment in fixed capital in manufacturing is computed for each year by subtracting book value of fixed assets in the previous year from that in the current year and adding to that figure the reported depreciation in fixed assets in the current year.[12] Gross fixed investment for the years 1971-72 to 1999-00 could be computed from the ASI data. The series has been extrapolated backwards to 1959-60 with the help of the series on gross fixed capital formation in registered

[12] Let B_t denote the book value of fixed assets in year t and D_t the reported depreciation in that year. Then, the gross investment in year t, denoted by I_t, may be obtained as $I_t = B_t - B_{t-1} + D_t$. It should be noted here that the ASI reports book value of fixed assets net of cumulative depreciation.

manufacturing (current prices) given in the NAS. To obtain real gross investment, the nominal figures have been deflated using the implicit deflator for fixed investment mentioned above. (3) The capital stock for 1979-80 (base year) is computed by aggregating real fixed investment for different years during 1959-60 to 1979-80 after making adjustment for annual depreciation. The rate of annual depreciation is taken as 5 per cent, which is the same as assumed in the studies of Unel and TSL. (4) Starting from the fixed capital stock for 1979-80 (benchmark) and adding real net fixed investment for successive years, the net fixed capital stock series is constructed.

Real intermediate input has been taken as the sum of values of materials, power and fuel, and other intermediate inputs, all expressed at constant prices of 1981-82.

The reported series on materials has been deflated to obtain materials input at constant prices. Following a common practice among productivity studies, a deflator for materials has been constructed with the help of an input-output table. The deflator is formed as a weighted average of price indices for various input-output sectors (for each sector, the best price series available from the official series on wholesale price indices has been used).[13] The 1993-94 input-output table prepared by the CSO has been used for this purpose. The columns in the absorption matrix for 66 sectors belonging to manufacturing have been added together. The sum of the columns so obtained gives the purchases of materials made by manufacturing industries from various sectors including supplies made by one industry to another as well as intra-industry transactions. This information is used to construct the weights.

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[13] A number of studies on productivity trends in Indian industries have constructed deflator for materials used in manufacturing in this manner. An input-output table provides the purchases made by manufacturing industries from different input-output sectors. These transactions are used as the basis to construct weights, and then a weighted average of price indices of different sectors is taken. See Rao (1996) and Goldar and Kumari (2003), among others.

Energy input at constant prices has been obtained in a manner similar to that used for materials. A price index for energy has been formed considering the expenditures incurred by manufacturing industries on coal, petroleum products and electricity as given in the input-output table for 1993-94 and using wholesale price indices for these three categories of energy inputs.

The difference between total input as reported in ASI and the cost of materials, power and fuel (which may be called other input cost) includes services purchased by the industrial units. Indeed, a major part seems to be on account of services.[14] Accordingly, a price index of services has been used for deflating this component of intermediate input. The deflator has been constructed from the *National Accounts Statistics* (NAS). The input-output table for 1993-94 provides information on the purchases of services (transport, banking and insurance, etc.) by the manufacturing sector in that year. For various services sectors, the NAS reports GDP (gross domestic product) at current and constant prices, which have been used to compute implicit deflators. A weighted average of the implicit deflators of different services sectors has been taken to construct a deflator of services purchased by manufacturing industries. The weights are based on the flows from the services sectors to the manufacturing industries as given in the input-output flow table.

3.2 Estimates of TFP Growth

The estimates of TFP growth in Indian manufacturing made in this study using the value-added function framework are presented in Table 1. These estimates are based on the Translog index of TFP (see Annex B for description of the index). TFP growth rates are shown for three periods: 1979-80 to 1990-91, 1991-92 to 1997-98 and 1991-92

[14] Refer to footnote 10 above. According to information obtained from the CSO (private communication from Director, Industrial Statistics Wing, CSO), the cost of work done by other units on materials supplied by the factory constituted about 12 percent of 'other input cost' in 2001-02. Some important cost items under 'other input cost' are (1) operating costs, (2) non-operating costs, (3) insurance charges, and (4) cost of repair and maintenance of building, plant and machinery, and other fixed assets. Considering the definition of 'total input' in ASI and available information on important cost items included in total input other than materials and energy, it appears that services form a major part of 'other input cost'.

to 1999-00.[15] To compute the average annual growth rate of TFP in each of these periods, a simple average of annual growth rates has been taken. A comparison is presented in the table with the estimates of TFP growth made by Unel (2003) who has also used the value-added function framework.

Table 1: TFP Growth in Indian Manufacturing, Estimates based on Value-Added Function Framework, 1979-90 to 1999-2000

Period	Average annual growth rate in TFP (per cent per annum)	
	This study	Unel (2003)
1979-80 to 1990-91	2.14 (2.14)	1.8
1991-92 to 1997-98	1.00 (0.91)	2.5
1991-92 to 1999-2000	1.57 (1.32)	Period not covered in the study

Note: Estimates in parentheses are based on net value added.

It is seen from the table that, contrary to the findings of Unel, the TFP estimates made in this study indicate a fall in the growth rate of TFP in Indian manufacturing in the period 1991-92 to 1997-98 as compared with the period 1979-80 to 1990-91. The estimated average annual growth rate in TFP is 2.14 per cent for the period 1979-80 to 1990-91[16] and much lower at 1.00 per cent for the period 1991-92 to 1997-98.[17] It may be noted further that the estimated average annual TFP growth rate for the period 1991-92 to

[15] The partitioning of the period under study into pre- and post-reform periods follows that adopted by Unel (2003).

[16] Growth rate in TFP over the previous year is computed for each of the years 1980-81 to 1990-91 and then an average is taken. The average annual growth rates in TFP for other periods have been computed in a similar manner.

[17] Since a net measure of capital input is used, it would be more appropriate to use net value added (net of depreciation) rather than gross value added as the measure of output. It may be noted here that both Unel and TSL study have used a net measure of capital input, but a gross measure of output. To maintain comparability of TFP estimates of this study with the estimates of Unel and TSL, this issue has been ignored. However, it would of interest to find out whether the TFP estimates based on net value added show the same inter-temporal pattern as the estimates based on gross value added. Hence, TFP growth estimates based on net value added (assuming 5% rate of depreciation) have also been worked out, and are presented in Table 1. According these estimates, TFP growth rate in India's organized manufacturing during 1979-80 to 1990-91 was 2.14 per cent per annum, and that during 1991-92 to 1997-98 was 0.9 per cent per annum. Thus, the TFP growth estimates based on net value added are similar to those based on gross value added, and both indicate a slowdown in TFP growth in Indian manufacturing in the post-reform period.

1999-00 exceeds that for the period 1991-92 to 1997-98, but is lower than that for the period 1979-80 to 1990-91.[18]

The differences in the estimates of TFP growth between this study and Unel (2003) can be traced in part to the benchmark capital stock estimation procedure. It seems, however, that there are other reasons for the differences in the estimates to arise. It should be noted that Unel's estimate of TFP growth rate for the post-reform period is more than twice the growth rate estimated in this study, and this cannot be explained by the difference in the benchmark capital stock estimates alone. To investigate this issue further, a comparison of estimated growth rates in output-labor ratio, capital-labor ratio and capital-output ratio in the pre- and post-reform periods is made in Table 2.

Table 2: Comparison of Growth rates in Output-labor ratio, Capital-labor ratio and Capital-output ratio, Indian Manufacturing, 1979-80 to1997-98

(average annual growth rate: per cent per annum)

Ratio	Period	This study	Unel (2003)
Output to labor	1979-80 to 1990-91	6.6	6.3
	1991-92 to 1997-98	6.5	7.8
Capital to labor	1979-80 to 1990-91	7.0	7.3
	1991-92 to 1997-98	7.7	7.0
Capital to Output	1979-80 to 1990-91	0.6	1.0
	1991-92 to 1997-98	1.2	-0.8

Unel's estimate of growth rate in output-labor ratio (labor productivity) in the post-reform period is higher than the estimate made in this study by more than one percentage point. Similarly, there is a noticeable difference in the estimates of growth

[18] Preliminary estimates of TFP growth in Indian manufacturing for 2000-01 and 2001-02 using the value-added function framework indicate that there was a fall in TFP in these two years, by about 7.5 per cent and 2.2 per cent respectively. This pulls down the average rate of TFP growth in Indian manufacturing in the post-reform period. The average annual growth rate in TFP for the period 1991-92 to 2001-02 is found to be only about 0.3 per cent per annum, much lower than the growth rate in TFP achieved during 1979-80 to 1990-91.

rate in capital-output ratio in the post-reform period. While the estimate made in this study indicates an increase in capital-output ratio, Unel's estimate indicates a fall. By comparison, there is a smaller difference in the estimated growth rate in capital-labor ratio in the post-reform period. It appears from Table 2 therefore that the difference in estimated TFP growth in the post-reform period between this study and Unel (2003) arises to a large extent from the difference in the estimated growth rate of output (real value added). Unel has not reported the growth rate of output, but this can be worked out from the reported growth rate in labor productivity. The average annual growth rate in employment in manufacturing in the period 1991-92 to 1997-98 was about 3.1 per cent per annum. Thus, considering the estimated growth rate of output-labor ratio, it may be inferred that the growth rate of output in the post-reform period in Unel's study should be about 11 per cent per annum (compared to about 9.8 per cent per annum in this study). From the series on GDP in registered manufacturing at 1993-94 prices reported in the NAS, the average annual growth rate for the period 1991-92 to 1997-98 is found to be about 9 per cent per annum.[19] It seems therefore that the real value added series constructed by Unel overstates growth in manufacturing output in the post-reform period, leading to an exaggeration of TFP growth.

We take up next the estimates of TFP growth in Indian manufacturing made in this study using the gross output function framework. These estimates of TFP growth are based on the Translog index (see Annex B). The estimated growth rates in the pre- and post-reform periods are presented in Table 3. A comparison is made with the TFP growth estimates in the TSL study, which has used the same framework. The TFP index presented in the TSL study indicates an increase in the average annual growth rate of TFP in the post-reform period, from 0.49 per cent in the period 1981-82 to 1990-91 to 1.2 per cent in the period 1991-92 to 1999-00. By contrast, the TFP estimates made in this study indicate a fall in the growth rate of TFP in the post-reform period. The average annual growth rate in TFP is found to be 0.92 per cent for the period 1981-82 to 1990-91 and

[19] Unel has not presented the output-input series in the paper, nor explained in sufficient detail how output of the manufacturing sector has been measured. It is therefore difficult to ascertain why the real value added series constructed by Unel exhibits for the post-reform period a faster growth than the series for registered manufacturing in the NAS.

0.68 per cent for the period 1991-92 to 1999-2000. The fall in the growth rate of TFP is more pronounced if a comparison is made between the periods 1980-81 to 1990-91 and 1991-92 to 1999-00.[20]

Table 3: TFP Growth in Indian Manufacturing, Estimates based on Gross Output Function Framework, 1981-82 to 1999-2000

Period	Average annual growth rate in TFP (per cent per annum)	
	This study	TSL (2003)
1981-82 to 1990-91	0.92	0.49*
1991-92 to 1999-2000	0.65	1.20*
1980-81 to 1990-91	1.37	Period not covered in the study

* Computed from the TFP index presented in TSL (2003), Appendix II.

It is evident from the above that the TFP estimates obtained in this study do not confirm the findings of the studies of Unel and TSL, although the basic data source is the same and the methodology of output, input and productivity measurement is quite similar.

4. Divergence between factor income shares and elasticity

The estimates of TFP growth presented in Tables 1 and 3 above are based on the growth accounting approach which involves the assumptions of constant returns to scale, competitive markets, and factors of production being paid according to their marginal products. These assumptions can be questioned, especially in the context of developing countries. Inasmuch as the elasticities of output with respect to inputs differ from the

[20] If 1991-92 and 1992-93 are taken as a part of the pre-reform period, as done in the TSL study, the average annual growth rate in TFP in organized manufacturing in the post-reform period is found to be relatively higher than that in the pre-reform period. The average TFP growth rate for the years 1993-94 to 1999-00 was about 0.8 per cent per annum as against an average growth rate of about 0.6 per cent per annum for the years 1982-83 to 1992-93. This is broadly in line with the findings of the TSL study. But, an important question is, should 1991-92 and 1992-93 be taken as a part of the pre-reform period. Also, there are indications of fall in TFP in Indian manufacturing in 2000-01 and 2001-02. The implication is that if the post-reform period is extended to 2001-02, the average growth rate in TFP in the post-reform period would probably be found to be lower than that in the pre-reform period.

income shares of inputs, the estimates of TFP based on the growth accounting approach would be biased.

Unel (2003) points out in his paper that there has been a sharp fall in the income share of labor in value added in the 1990s[21] (the share was about 40 per cent in the early 1980s which came down to about 25 per cent by the late 1990s). He argues that the income share of labor in Indian manufacturing significantly understates the elasticity of output with respect to labor, particularly for the post-reforms period. He refers to Ahluwalia's production function estimates for Indian manufacturing in which the relevant elasticity was found to be between 0.57 and 0.65 (Ahluwalia, 1991). He also refers to the labor's share in income in manufacturing in G5 countries, where it ranges between 0.50 and 0.75. Accordingly, Unel has presented a second set of estimates of TFP growth in Indian manufacturing taking the elasticity of output with respect to labor as 0.6 rather than the actual income share reported in the ASI.

Unel has, no doubt, raised a valid point. However, to address this issue squarely, it is important that a production function be carefully estimated for Indian manufacturing using data for the last two decades. It needs to be recognized in this connection that the observed decline in the income share of labor could be due to a labor-saving bias in technological change, or it could be a result of inter-temporal changes in factor proportions leading to a decline in the elasticity of output with respect to labor. Thus, the specification of the production function should be such that it allows the elasticity to change over time. Also, it should be possible to test whether or not the elasticity has declined in the 1990s.

On the above considerations, a constant-returns-to-scale[22] Translog production (value-added) function has been estimated for Indian manufacturing using panel data for

[21] See Balakrishnan and Suresh Babu (2003), and Goldar and Aggarwal (2004) in this context.
[22] The assumption of constant returns to scale is made for maintaining consistency with the framework underlying the TFP estimates presented in Table 1.

17 two-digit industries (comprising the manufacturing sector) for the period 1981-82 to 1997-1998.[23] The production function is specified as:

$$\ln Y = \alpha + \beta_L \ln L + \beta_K \ln K + \beta_T T + \tfrac{1}{2}\beta_{LL}(\ln L)^2 + \tfrac{1}{2}\beta_{KK}(\ln K)^2 + \tfrac{1}{2}\beta_{TT}T^2 + \beta_{LK}(\ln L)(\ln K) + \beta_{LT}(\ln L)T + \beta_{KT}(\ln K)T \quad (1)$$

In this equation, Y denotes output (value added), L labor and K capital. T denotes time (year). The assumption of constant-returns-to-scale requires:

$\beta_L + \beta_K = 1$; $\beta_{LL} + \beta_{LK} = 0$; $\beta_{KK} + \beta_{LK} = 0$; $\beta_{LT} + \beta_{KT} = 0$ …. (2)

The rate of technological change (TC) is given by:

$TC = \beta_T + \beta_{TT} T + \beta_{LT} \ln L + \beta_{KT} \ln K$ …(3)

Technological change is Hicks-neutral if $\beta_{LT} = \beta_{KT} = 0$. The elasticity of output with respect to labor (E_L) is given by:

$E_L = \beta_L + \beta_{LL} \ln L + \beta_{LK} \ln K + \beta_{LT} T = \beta_L + \beta_{LK} \ln (K/L) + \beta_{LT} T$ …(4)

It is evident from the above equation that inter-temporal changes in the elasticity of output with respect to labor depend on changes in capital-labor ratio and the bias in technological change represented by the parameter β_{LT}.

The estimate of the production function given in equation (1) above is presented in Table 4. The parameters have been estimated by the restricted least-squares method. Two sets of results are presented, both based on panel data. The first set does not include dummy variables for industries, the second one does, which makes it the fixed-effects model.

[23] This data-set on real gross value added, employment and gross fixed capital stock at constant prices for two-digit industries was constructed for the study undertaken by Goldar and Kumari (2003). The details on the data and construction of variables are available in that study.

Table 4: Estimates of the Translog Production (Value-Added) Function for Indian Manufacturing

Parameter	Estimate by the restricted least-squares method	Estimate by the restricted least-squares method with industry dummies
α	-1.0939(-7.84)	-0.9270(-4.17)
β_L	0.7719(6.78)	0.7596(4.98)
β_K	0.2281 (2.03)	0.2404(1.31)
β_T	0.0817(2.78)	0.0701(2.42)
β_{LL}	-0.1541 (-2.92)	0.0807(1.01)
β_{KK}	-0.1541(-2.92)	0.0807(1.01)
β_{TT}	-0.0062(-4.03)	-0.0054(-2.45)
β_{LK}	0.1541 (2.92)	-0.0807(-1.01)
β_{LT}	-0.0368(-3.73)	0.0001(1.12)
β_{KT}	0.0368(3.73)	-0.0001(-1.12)
Industry dummies	no	Yes
R^2	0.9096	0.9824

Note: The specification of the production function is given in equation (1). Panel data for 17 two-digit industry groups for 17 years, 1981-82 to 1997-98, are used. t-ratios in parentheses

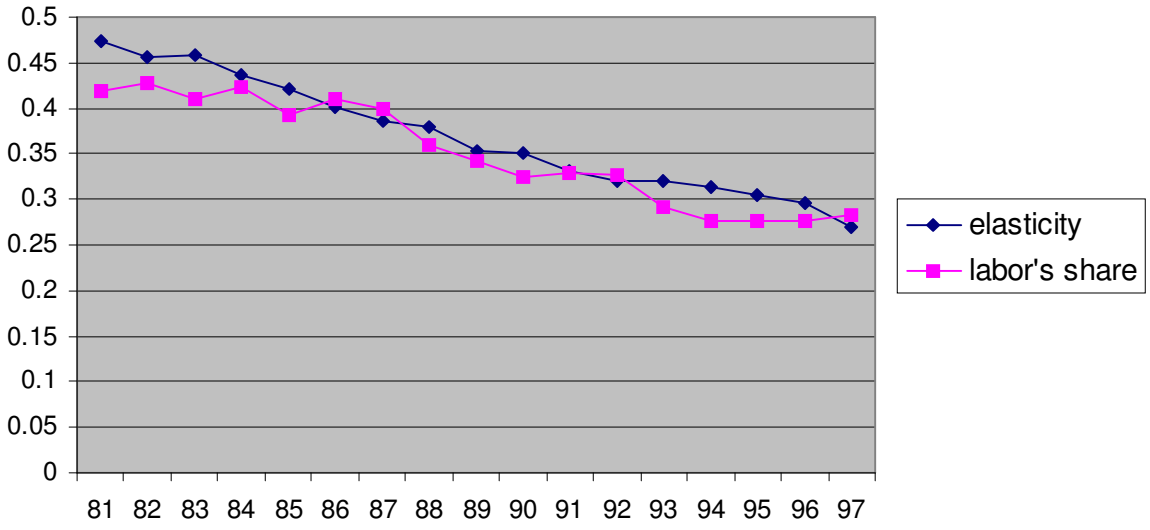
The estimated production functions in Table 4 satisfy the monotonicity and concavity conditions[24] at the sample mean for each year. However, the second set of results, the fixed-effects model, may be regarded as less satisfactory than the first set, because several estimated coefficients are statistically insignificant. Therefore, the first set of results have been used for deriving the elasticity of output with respect to labor at sample average for each year, 1981-82 to 1997-98. The computed elasticity exhibits a clear downward trend. This is depicted in Figure 1 along with the actual income share of labor. It is interesting to note that there is only a small gap between the income share of labor and the elasticity of output with respect to labor, and both have declined over time.

Based on the estimated parameters of the translog production function, it seems reasonable to infer that the downward trend in the income share of labor in value added in

[24] These conditions need to be satisfied by well-behaved production functions.

manufacturing in the 1990s was largely due to labor-saving technological change.[25] There are no indications of a growing divergence between labor income and elasticity in the 1990s.

Figure 1: Labor's share in value added and elasticity of output with respect to labor, Indian manufacturing, 1981-82 to 1997-98



Using the elasticity estimates derived from the estimated production function (depicted in Fig.1), TFP growth rates have been computed for different year. The average annual growth rates in TFP in the pre-reform and post-reform periods have been computed and these are shown in Table 5. A comparison is made with the second set of estimates of TFP growth made by Unel (which are based on the assumption that the elasticity of output with respect to labor is constant and equal to 0.6).

[25] To verify this finding, the Translog production (value-added) function has been estimated for the manufacturing sector using another data-set: data on real value added, employment and net fixed capital stock for 41 major industry groups (comprising the manufacturing sector) for the period 1980-81 to 1999-00. This data-set was prepared for a study on the impact of industrial tariff reforms carried out at the ICRIER (Virmani, et al. 2003, 2004). The estimate of β_{LT} was found to be negative (-0.011) and statistically significant at one per cent level (t-ratio=-3.27), indicating a labor-saving bias of technological change. The estimated elasticity of output with respect to labor showed a clear downward trend, as in Figure 1.

Table 5: TFP Growth in Indian Manufacturing, Estimates based on Production Function Parameters, 1979-90 to 1999-2000

Period	Average annual growth rate in TFP (per cent per annum)	
	This study	Unel (2003)
	E_L derived from the production function	E_L = 0.6 for both pre-reform and for post-reform periods
1979-80 to 1990-91	2.23	3.2
1991-92 to 1997-98	1.08	4.7
1991-92 to 1999-2000	1.65	Period not covered in the study

Note: E_L is the elasticity of output with respect to labor.

The use of elasticities derived from the estimated production function for the computation of TFP indices does not alter the relative standing of growth rates of TFP in the pre-reform and post-reforms periods. The estimates made in this study indicate a fall in the growth rate of TFP in the post-reform period contrary to the pattern indicated by the TFP estimates of Unel.

5. Conclusion

Contradicting the findings of several earlier studies, two recent studies, one by Unel (2003) and the other by the Tata Services Limited (TSL) (2003), have concluded that there was an acceleration in total factor productivity (TFP) growth in Indian manufacturing after the 1991 economic reforms. A close look at the methodology adopted in these two studies, however, revealed certain shortcomings. An alternative set of estimates of total factor productivity growth in Indian manufacturing were presented in the paper, which were made following by and large the methodology of input and output measurement adopted in the studies of Unel and TSL but avoiding the methodological inadequacies noticed in these studies. The estimates did not bear out the findings of the studies by Unel and TSL.

Based on the findings of earlier studies on TFP growth in Indian manufacturing as well as the evidence presented in this paper, it seems it would be right to conclude that there has been a decrease, not an increase, in the growth rate of TFP in Indian manufacturing in the post-reform period. 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, 2003) 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.

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Annex A: Output and Input, Indian Manufacturing, 1979-80 to 1999-00

Year	Gross value of output at 1981-82 prices (Rs. Billion)	Gross value added at 1981-82 prices (Rs. billion)	Employment ('000)	Net fixed capital stock at 1981-82 prices Rs. billion)	Value of intermediate inputs at 1981-82 prices (Rs. billion)
1979-80	605.7	135.3	6805	379.6	Not computed
1980-81	590.3	125.3	6922	397.7	490.0
1981-82	671.3	138.2	6965	423.2	533.1
1982-83	758.0	154.5	7182	449.7	570.9
1983-84	764.5	173.8	6946	498.3	577.2
1984-85	816.9	180.8	6867	526.9	620.5
1985-86	877.3	189.4	6579	555.5	666.6
1986-87	920.0	192.0	6524	580.8	698.2
1987-88	994.3	209.8	6822	628.4	746.5
1988-89	1100.1	234.9	6845	688.5	816.2
1989-90	1238.7	261.8	7226	744.3	948.6
1990-91	1345.5	287.5	7297	853.6	1029.4
1991-92	1329.3	278.6	7361	911.2	1018.9
1992-93	1461.3	311.6	7846	1021.3	1124.0
1993-94	1537.4	349.9	7825	1110.9	1153.9
1994-95	1681.6	386.2	8112	1246.8	1270.7
1995-96	1997.7	455.1	8951	1441.6	1508.8
1996-97	2028.1	470.9	8757	1525.5	1492.8
1997-98	2306.0	484.0	8789	1695.7	1692.6
1998-99	2393.9	529.2	8539	1908.0	1732.6
1999-00	2669.6	560.9	8117	1950.4	1981.3

Source: Computed from ASI data, as explained in the text.

Annex B: Translog Index of Total Factor Productivity

The Translog index of Total Factor Productivity (TFP) is a discrete approximation to the Divisia index of technical change. It has the advantage that it does not make rigid assumptions about elasticity of substitution between factors of production (as for instance done by the Solow index). It allows for variable elasticity of substitution. Another advantage of the 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 even if the technological change is non-neutral.

For the two-input case, taking value added as output, and labor and capital as inputs, the Translog index of TFP growth is given by the following equation:

$$\Delta \ln TFP(t) = \Delta \ln Y(t) - [\frac{SL(t) + SL(t-1)}{2} \times \Delta \ln L(t)] - [\frac{SK(t) + SK(t-1)}{2} \times \ln \Delta K(t)] \quad ...(A.1)$$

In the above equation, Y is output, L labor and K capital. SL is income share of labor and SK denotes income share of capital. Δ ln Y(t) = ln Y(t) – ln Y(t-1). In the same way, Δ ln L(t), and Δ ln K(t) are defined. SK and SL add up to unity. Δ ln TFP is the rate of technological change or the rate of growth of TFP.

Under the three-input framework, the Translog index of TFP growth is given by the following equation:

$$\Delta \ln TFP(t) = \Delta \ln Q(t) - [\frac{SL(t) + SL(t-1)}{2} \times \Delta \ln L(t)] - [\frac{SK(t) + SK(t-1)}{2} \times \Delta \ln K(t)] - [\frac{SM(t) + SM(t-1)}{2} \times \Delta \ln M(t)]. \quad ...(A.2)$$

In this equation, Q denotes gross output, L labor, K capital and M materials (including energy and services) input. Δ ln Q(t) = ln Q(t) – ln Q(t-1). In the same way, Δ ln L(t), Δ ln K(t) and Δ ln M(t) are defined. SL is the income share of labor, SK is the income share of capital, and SM is the income share of materials input. SL, SK and SM add up to unity. Δ ln TFP is the rate of technological change or the rate of growth of TFP.

Annex C: Employment and Output Growth in India's Organized Manufacturing Sector since the Mid- 1990s

Employment Growth

According to ASI data, the trend growth rate in employment in the organized industrial sector in the period 1973-74 to 1990-91 was about 1.6 per cent per annum (see Table A.1). The trend growth rate in employment was relatively much higher at about 3.4 per cent per annum in the period 1990-91 to 1997-98. However, the tempo in industrial employment growth could not be maintained in subsequent years. Rather, there was a fall in industrial employment during 1997-98 to 2001-02 (see Table A.1 and Figure A.1). The aggregate factory sector results of ASI show a fall in employment by about 2.3 million persons between 1997-98 and 2001-02 (a fall by about 23 per cent or 5.8 per cent per annum). This comparison of employment figures in ASI is, however, flawed because the two-digit industry group 40 (power generation, transmission and distribution) has been excluded from ASI since 1998-99. The effect of this reduction in industrial coverage in ASI data is clearly visible in Figure A.1. The line for ASI-total is above that for manufacturing for all years before 1998-99. From 1998-99 onwards, the two lines almost coincide.

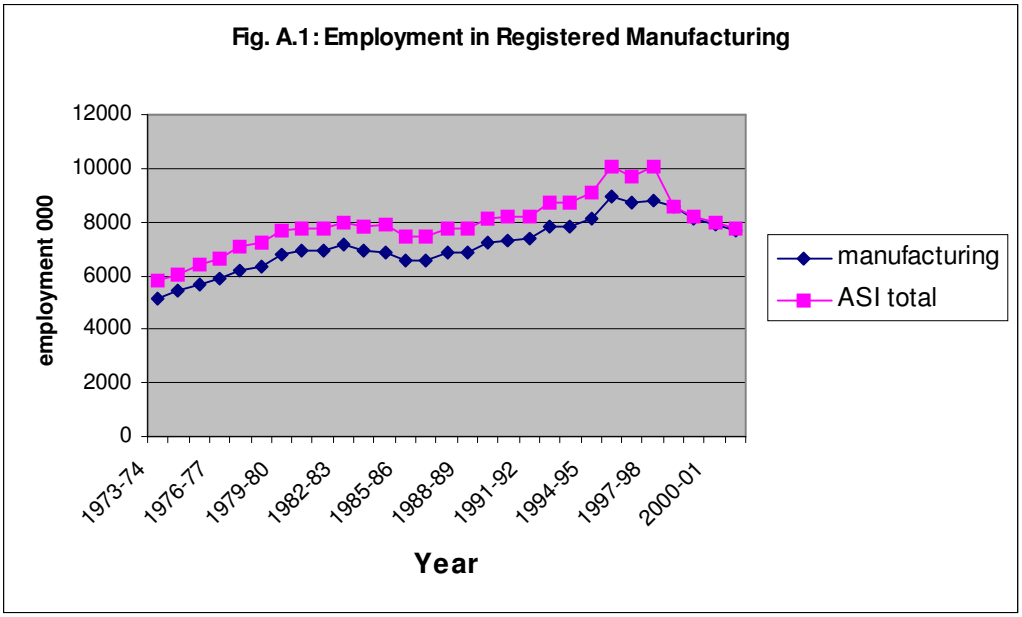


Table A.1: Employment in Organized Industrial Sector ('000)

Year	Manufacturing	ASI total
1973-74	5140	5820
1974-75	5407	6053
1975-76	5663	6381
1976-77	5865	6649
1977-78	6222	7093
1978-79	6368	7248
1979-80	6805	7678
1980-81	6922	7715
1981-82	6965	7778
1982-83	7182	8010
1983-84	6946	7824
1984-85	6867	7872
1985-86	6579	7472
1986-87	6524	7442
1987-88	6822	7786
1988-89	6845	7743
1989-90	7226	8143
1990-91	7297	8163
1991-92	7361	8194
1992-93	7846	8705
1993-94	7825	8708
1994-95	8112	9102
1995-96	8951	10045
1996-97	8757	9707
1997-98	8789	10073
1998-99	8539	8589
1999-00	8117	8173
2000-01	7933	7988
2001-02	7697	7750
Trend growth rate (per cent per annum)		
1973-74 to 1990-91	1.6	1.6
1990-91 to 1997-98	3.1	3.4
1997-98 to 2001-02	-3.3	-5.8

Note: Employment series for manufacturing up to 1998-99 is obtained from ASI data. This has been extrapolated for subsequent years using ASI results for factory sector.

It is evident from the above that there is a problem of data incomparability in aggregate factory sector results of ASI for recent years.[26] However, the observed fall in industrial employment in the factory sector results of ASI is not entirely due to a change in industrial coverage. Even after adjustments are made for changes in industrial coverage, ASI results show a downward trend in employment in organized industry in the period since the mid-1990s. Estimates of employment in organized manufacturing based on the ASI data indicate that the trend rate of growth in employment in the period 1997-98 to 2001-02 was negative, at about –3.3 per cent per annum (see Table A.1 and Figure A.1).[27]

Table A.2 presents a comparison of growth rates in labor income (unadjusted for price change) in the 1990s between two data sources: ASI results for organized manufacturing are compared with data for corporate sector manufacturing firms reported by the CMIE (Center for Monitoring Indian Economy, Mumbai). The corporate sector manufacturing firms account for about 70 per cent of value added in organized manufacturing, and therefore it would be useful to compare ASI data with the data on corporate sector manufacturing firms.

It is seen from Table A.2 that the average growth rates in labor income for the years 1991-92 to 1997-98 indicated by the two data sources are close to each other. But, for the years 1998-99 to 2001-02, the ASI data show a markedly slower average growth rate in labor income.

Deflating the figures on wages and salaries payment in corporate sector manufacturing firms by emoluments per employee in the ASI data,[28] it is possible to obtain a crude estimate of employment growth in the corporate sector manufacturing firms. The estimated growth rate of employment is 3.4 per cent per annum for the period 1990-91 to 1997-98 and 0.3 per cent per annum for the period 1997-98 to 2001-02. It seems therefore that there was an increase in employment in corporate sector manufacturing firms in the period 1997-98 to 2001-02, though the ASI results indicate a fall in employment in organized manufacturing in this period.

[26] This needs to be emphasized because researchers are not sufficiently aware of the recent change in industrial coverage of ASI. The TSL (2003) study, for instance, has used the aggregate factory sector series of ASI till 1999-00 for studying trends in industrial productivity without noticing the change in industrial coverage. There is a possibility that some other researchers may make the same mistake.

[27] According to the quick estimates of ASI for 2002-03, employment in the factory sector was 7890 thousand. This is 1.8 per cent higher than the estimate for 2001-02. Applying the same proportion to manufacturing employment, the trend growth rate in employment in organized manufacturing in the period 1997-98 to 2002-03 is found to be –2.6 per cent per annum. The trend growth rate in organized manufacturing employment in the period 1990-91 to 2002-03 comes to about 0.5 per cent per annum, lower than the growth rate in the period 1973-74 to 1990-91 (1.6 per cent per annum).

[28] Several studies have used wage rate in ASI data to make an estimate of employment in corporate sector manufacturing firms. See, for example, Srivastava (1996).

Table A.2: Comparison of Growth Rates in Labor Income, ASI results for organized manufacturing and CMIE data on corporate sector manufacturing firms

Year	ASI manufacturing sector: Growth rate in total emoluments over the previous year	Corporate sector- manufacturing firms: Growth rate in wages and salaries over the previous year
1991-92	9.2	15.0
1992-93	23.4	12.3
1993-94	8.3	11.4
1994-95	17.1	17.5
1995-96	27.8	22.6
1996-97	5.8	5.4
1997-98	8.3	11.8
1998-99	2.8	10.5
1999-00	7.2	11.8
2000-01	6.0	14.0
2001-02	0.7	-0.9
Averages for periods		
1991-92 to 1997-98	14.3	13.7
1998-99 to 2001-02	4.2	8.9

It is seen from the above that the trends in industrial employment and labor payments indicated by the ASI data for the period 1997-87 to 2001-02 differ somewhat from the trends indicated by data for corporate sector manufacturing firms. The reason for this difference is not clear. One possibility that come to mind is that factories not belonging to corporate sector firms may have suffered a major set back in terms of employment generation in recent years. The fall in employment in such factories far exceeded the increase in employment in corporate sector manufacturing firms. This is an issue that requires further investigation.

Output Growth

Table A.3 presents a comparison of trend growth rates in four indicators of output of organized manufacturing sector. A graphic presentation is made in Figure A.2. The growth rates are for interlocking periods of five-years each between the years 1973-74 and 2001-02. The indicators of output considered are (a) gross domestic product of registered manufacturing at 1993-94 prices given in the National Accounts Statistics (hereafter GDP-RM), (b) deflated gross value added of organized (registered) manufacturing based on ASI data (hereafter RGVA), (c) deflated gross output of organized manufacturing based on ASI data (hereafter RGO), and (d) Index number of industrial production for manufacturing (hereafter IIP).

Table A.3: Trend Growth Rate in Manufacturing Output: Interlocking Five-year periods between 1973-74 and 2001-02

Five –year period ending	Trend growth rate (per cent per annum)			
	GDP in registered manufacturing at constant prices	Real Gross Value Added in Organized Manufacturing	Real Gross Output Value of Organized Manufacturing	Index number of industrial production for manufacturing
1977-78	5.5	6.9	11.2	5.6
1978-79	8.1	8.9	11.7	6.6
1979-80	7.2	8.3	9.2	4.9
1980-81	3.5	3.3	5.2	3.1
1981-82	2.5	1.6	4.0	3.5
1982-83	3.2	2.2	5.4	3.3
1983-84	7.7	7.4	7.4	4.6
1984-85	10.5	10.1	8.1	5.3
1985-86	9.2	8.2	6.3	6.3
1986-87	7.2	5.3	5.4	8.3
1987-88	5.5	4.5	6.7	8.9
1988-89	6.4	6.5	7.5	8.9
1989-90	9.2	8.9	9.1	8.6
1990-91	9.7	10.8	10.3	8.6
1991-92	7.2	8.0	8.1	6.8
1992-93	4.1	6.5	6.6	4.5
1993-94	3.4	6.8	5.3	3.4
1994-95	6.6	8.5	6.1	4.2
1995-96	11.3	12.7	10.0	7.9
1996-97	13.2	11.5	9.6	9.9
1997-98	10.2	8.8	10.5	9.3
1998-99	6.1	5.7	8.2	7.6
1999-00	3.1	3.3	6.8	6.1
2000-01	3.0	1.1	6.3	5.8
2001-02	4.7	-0.3	3.9	5.5

Fig A.2: Manufacturing output growth

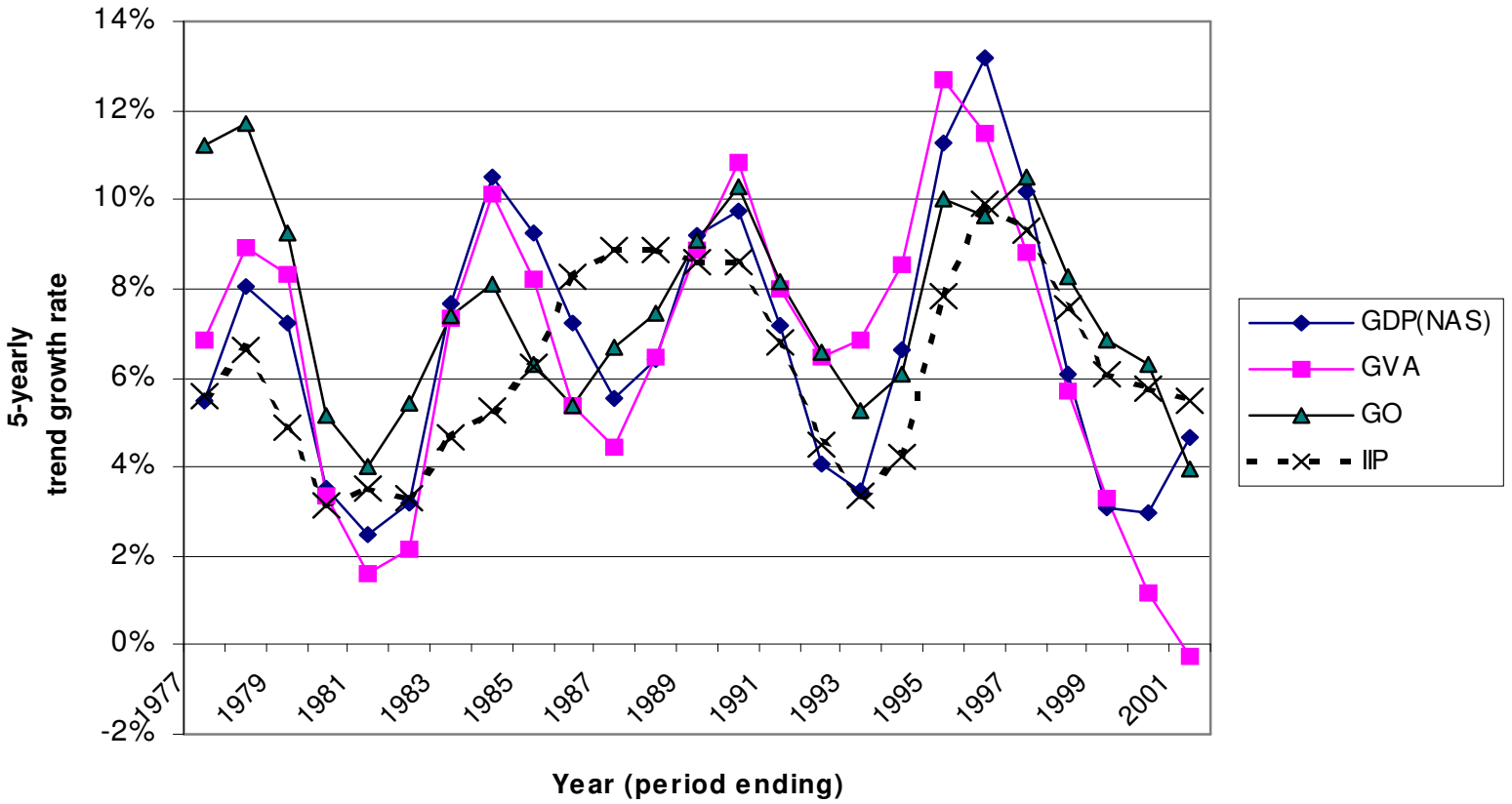


Table A.3 and Figure A.2 bring out clearly a cyclical pattern in the growth rate of industrial output, with peaks occurring after about six years. Growth rates in GDP-RM, RGVA and RGO by and large move together. The movements in growth rates in GDP-RM and RGVA are particularly close. This is not surprising because the GDP series for registered manufacturing reported in the NAS is based mostly on the ASI results.[29]

Movements in the growth rate in IIP (index number of industrial production) differ somewhat from the movements in the growth rates in the other three indicators, for some part of the 1980s. But, for the late 1980s and much of the 1990s, the movements in the growth rate in IIP accord well with the movements in the other three indicators (see Figure A.2).

The movements in the growth rate in RGVA (real value added) increasingly diverged from the movements in the growth rates in IIP (industrial production index) and RGO (real gross output) in the period since the mid-1990s. In the five-year period ending 2001-02, the trend growth rate in RGVA was marginally negative, while it was about 5.5 per cent per annum for IIP and about 3.9 per cent per annum for RGO. The growth rate in GDP-RM was about 4.7 per cent per annum, closer to the growth rate in IIP than to the growth rate in real value added in organized manufacturing.

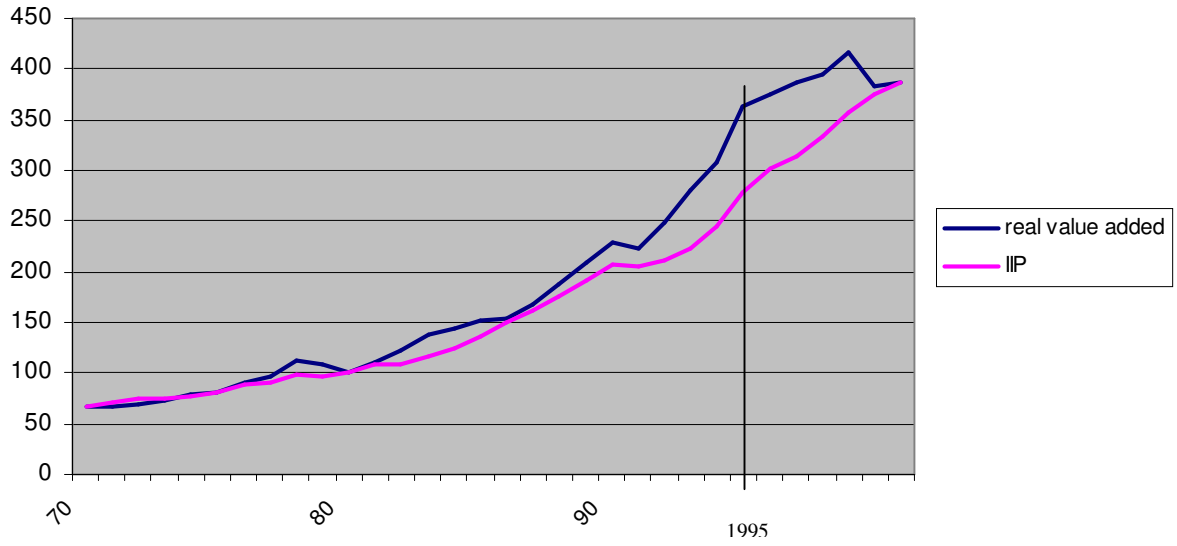
Table A.4 presents a comparison of trend growth rates in the four indicators of output of organized manufacturing for three periods: 1973-74 to 1990-91, 1990-91 to 1996-97 and 1996-97 to 2001-02. It is seen from the table that the growth rate in real value added exceeded the IIP during both 1973-74 to 1990-91 and 1990-91 to 1996-97. But, in the more recent period, 1996-97 to 2001-02, the growth rate in real value added fell far short of the growth rate in IIP. While the growth rate in the production index was about 5.4 per cent per annum, that in real value added was a meager 0.5 per cent per annum (see Figure A.3 which shows that real value added grew faster than IIP in the first half of the 1990s and subsequently it grew much slower than the IIP).

Table A.4: Comparison of Trend Growth Rate in Manufacturing Output, by Sub-periods

Period	Trend growth rate (per cent per annum)			
	GDP in registered manufacturing at constant prices	Real Gross Value Added in Organized Manufacturing	Real Gross Output Value of Organized Manufacturing	Index number of industrial production for manufacturing
1973-74 to 1990-91	6.7	6.4	7.4	6.0
1990-91 to 1996-97	9.5	10.0	8.1	7.0
1996-97 to 2001-02	3.7	0.5	5.3	5.4

[29] For the last two years of the period under study, 2000-01 and 2001-02, the reported GDP of registered manufacturing in NAS is not based on ASI but on the index number of industrial production.

Fig. A.3: Manufacturing: Real value added (index) and Index of Industrial Production



Note: To facilitate comparison, real value added is expressed as an index with base 1980-81=100, which is the base year also of the index number of industrial production.

Interestingly, the growth rate in deflated gross output in the period 1996-97 to 2001-02 is almost equal to the growth rate in IIP. Thus, growth in real value added in organized manufacturing in this period was much lower than the growth rate in real gross output.

Table A.5 compares growth rate in gross value added and gross output (both at current prices) in organized manufacturing given by ASI with the corresponding growth rate for corporate sector manufacturing firms. The comparison is made for the years 1991-92 to 2001-02. The average growth rates are shown at the bottom of the table for the years 1991-92 to 1996-97 and 1997-98 to 2001-02.

The comparison of growth rates presented in Table A.5 shows that the average growth rate in gross value added in the ASI results for organized manufacturing exceeds that for corporate sector manufacturing firms for the period 1991-92 to 1996-97. But, the average growth rate for the years 1997-98 to 2001-02 is relatively much lower in the ASI results than the data for corporate sector manufacturing firms. There is relatively less difference in the growth rate of gross output.

The largest discrepancy between the growth rate in industrial output indicated by the ASI and that indicated by other data sources is for 2000-01. The growth rate in real value added in organized manufacturing indicated by ASI is –8.3 per cent (fall), while the growth rate in IIP is 5.2 percent. The growth rate in GDP in registered manufacturing

reported in NAS is 7.7 per cent. It would be noticed from Table A.5 that while value added at current prices increased by 10.7 per cent in corporate sector manufacturing firms, it fell by 5.3 per cent in registered manufacturing according to ASI data.

The evidence presented above would lead one to suspect that the growth rate in real value added in organized manufacturing in the period 1996-97 to 2001-02 indicated by the ASI data understates to a certain extent the actual growth performance. The extent of underestimation of industrial growth seems to be most marked for 2000-01.

Table A.5: Growth Rates in Value Added and Gross Output In Organized Manufacturing, ASI Results vs. CMIE data on Corporate Sector Manufacturing Companies

Year	Growth rate over the previous year			
	Gross value added		Gross output	
	ASI	CMIE – corporate sector manufacturing firms	ASI	CMIE - corporate sector manufacturing firms
1991-92	7.8	17.1	9.9	17.2
1992-93	24.0	10.8	21.9	13.0
1993-94	21.1	14.8	13.4	11.9
1994-95	24.2	26.9	23.0	27.9
1995-96	27.8	23.7	28.8	22.3
1996-97	5.6	6.2	3.6	10.3
1997-98	5.8	6.7	17.0	4.5
1998-99	6.5	5.3	5.3	10.7
1999-00	8.7	9.6	14.6	16.8
2000-01	-5.3	10.7	3.2	18.0
2001-02	2.9	2.8	3.8	-1.3
Average for periods				
1991-92 to 1996-97	18.4	16.6	16.8	17.1
1997-98 to 2001-02	3.7	7.0	8.8	9.7

Note: The growth rates are computed from data on gross value added and gross output at current prices. Data for corporate sector companies have been taken from *Business Beacon* (CMIE).