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PRODUCTIVITY GROWTH IN INDIAN MANUFACTURING DURING THE PERIOD 1980-81 TO 2009-2010

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ABSTRACT

In this study an attempt is taken to estimate the growth rate of total factor productivity (TFP) in Indian manufacturing during the period 1980-81 to 2009-2010. Here it also examines that whether the TFP growth increases in post reform period compare to pre reform period and identify the sources of output growth in Indian manufacturing. The findings of the study indicate that output growth in two digit Indian manufacturing industries is driven mainly by inputs accumulation. The growth rate of total factor productivity in almost all the industries under our study is positive except Food products and beverage during the post-reforms period. In case of all India manufacturing the TFP growth increases in later years of post reform period.

Key words: Growth, Total Factor Productivity, Indian manufacturing.

Introduction

Productivity growth has been a matter of both curiosity and concern for economic dynamism of an economy. Output may increase due to larger use of inputs or from improvement in productivity of inputs or both. Productivity is the ratio of amount of output produced to the quantity of factor input used in the production. Growth in productivity and efficiency is very essential due to the fact that resources are limited and their proper use is very important for sustaining a high growth in output in the long run and it strengthens the cost competitiveness of

industries. Growth in productivity means getting more output from the same inputs or alternatively using fewer inputs to obtain the same output. Output growth from larger application of inputs is not as relevant for cost competitiveness of industries and sustainability of output growth. So Productivity growth is necessary and essential. An attempt is made in this chapter to estimate the trends in partial factor productivity and total factor productivity growth in the Indian organized manufacturing industries over the period from 1980-81 to 2009-10. The role of factor input growth and total factor productivity growth in accounting for the growth of output is also accounted. The productivity analysis is conducted at 2-digit industry level and the aggregate manufacturing as a whole. The period of the study chosen from 1980-81 to 2009-10 has been divided into two sub periods i) Pre reform period spans from 1980-81 to 1990-91 and ii) Post reform period 1991-92 to 2009-10.

The rest of this chapter is organized as follows. Section 2, reviews the brief literature on total factor productivity (TFP) with reference to Indian manufacturing sector. Description of data and construction of variables are provided in section 3. In section 4, the relative importance and relative positions of the so selected industries in Indian manufacturing are discussed. Section 5 contains the growth rates of selected variables and factor of factors. Section 6 deals with methodology of productivity growth. Section 7 contains the empirical findings and the final section contains concluding remarks.

2. Brief Literature: A number of studies[1] have been done related to factor productivity generally total factor productivity growth in Indian manufacturing. Krishna (1987) in his review of studies during the 1960s and 1970s observed that all studies agreed upon a deceleration in total factor productivity (TFP) since the 1960s. Ahluwalia (1991) and Srivastava (1996) observed a decline in total factor productivity during the 1970s and a turnaround in the second half of the 1980s. But the findings of total productivity growth estimates in the post reform periods are controversial and inconclusive. A few of studies, including Unel (2003) and Tata services limited (2003) showed that productivity growth in the post reform period has improved. But a stream of other studies, including Goldar (2000&2004), Trivedi (2000), Goldar and

1. The literature of productivity growth in Indian manufacturing has been reviewed earlier by Balakrishnan and Pushpangadan (1998) and Golder (2000)

Kumari (2003) and Das (2003), have found a fall in productivity growth in the post reform period. Goldar and Kumari (2003) argued that underutilization of industrial capacity is an important cause of the productivity slowdown in the post reform period and with correction for capacity utilization, they observed that productivity growth in 1990s is nearly at the same level as during 1980s.

From the above studies, it is observed that there is a divergent opinion on the productivity growth of Indian manufacturing. Now it is the ongoing time of structural reforms of Indian economy. So the objectives of our study to understand the relative importance and positions of Indian manufacturing industries, growth rates of variables, share of factors and estimate the TFP growth in Indian manufacturing in pre reform period and post reform period. Here we are particularly interested to know the sources of output growth whether it is driven by input growth or productivity growth, so the partial productivity of factors and total factor productivity are to be estimated for Indian manufacturing industries. This study is different from others at least two respects. First, we have constructed the real inputs and output by using appropriate deflator. Capital stock is measured in PIM (perpetual inventory method) which is different from others. Second, we have considered the post reform period of Indian manufacturing by focusing on more recent periods.

3. Description of Data and Construction of Variables

3.1 Description of Data

The ASI (Annual survey of industries) data published by CSO (Central Statistical Organization) ,Government of India is used to estimate total factor productivity (TFP) growth in Indian organized manufacturing for the period 1980-81 to 2009-10. During the period under study a several times National Industrial Classification newly framed. Therefore there is need some necessary adjustments to make figures of industries comparable. We have treated the NIC-2004 as the benchmark and accordingly some concordance have been done at the two-digit industry level which is given in appendix.

1. The literature of productivity growth in Indian manufacturing has been reviewed earlier by Balakrishnan and Pushpangadan (1998) and Golder (2000)

As per NIC-2004, India's manufacturing sector consists of 23 two-digit industries and out of these we have selected only 12 industries since these are major industries in the sense of higher share in gross output, employment and net value added of the manufacturing sectors a whole. These twelve selected industries are 1) Food products & beverages (13.97%)[1] 2) Textiles products (11.30%) 3) Coke, petroleum products & nuclear fuel (8.09%) 4) Chemicals and chemical products (13.13%) 5) Rubber and Plastic products (2.59%) 6) Non-metallic Mineral products (3.35%) 7) Basic Metals (12.12%) 8) Fabricated metal products (1.93%) 9) Machinery & equipment n.e.c (4.41%) 10) Electrical Machinery and Apparatus n.e.c (4.04%) 11) Motor vehicles, trailers & semi-trailers (3.09%), 12) other transport equipments (2.55%). These 12 industries comprises of 80.55% shares in net value added and remaining 11 industries accounting for remaining 19.45% share in the aggregate manufacturing. The remaining 11 two-digit industries were put together in a category defined as 'Others'.

3.2 Construction of Variables

Output: Output is measured by real gross output. The variables reported in ASI have been converted in real terms by deflating the nominal figures by the whole sale price index (WPI) for the respective industries. The WPI series are drawn from the office of Economic adviser (OEA), the Ministry of Commerce and Industry of India and have been spliced and arithmetically converted to 2004-05 base to use 2004-05=100 as base year.

Labour: Total persons engaged, as reported in ASI, have been taken as the measure of labour input.

Capital: Since the ASI reported data on fixed capital stock is at the historic cost. So we have converted the same to replacement cost**.** A real capital stock series K_t is constructed using the perpetual inventory method, as given by the expression:

$$K_t = (1-\delta)\, K_{t-1} + I_t$$

Where I_t is gross investment and δ is the depreciation rate. The measurement of capital stock for two-digit industries and aggregate manufacturing is given in detail in appendix A.

Material: Total input reported in ASI is taken as material input. The materials represents the series on materials (including energy and services) consumed by industry. To arrive at its

consumption at constant prices, it has been deflated by the industry specific weighted price index of materials.

Since for an industry the use of materials consisting of different types of items with different amounts, depending upon the nature of the industry, the series of materials and fuel consumed has been deflated by the weighted price index of respective industry. The industry specific weighted price index has been constructed through price index of various commodities combining with using appropriate weights (representing the share of the intermediate input costs). The weights have been taken from the 'Input-Output' table published by Central Statistical Organization (CSO). The CSO Input-Output tables 1993-94, 2003-04 and 2006-07 are used to construct weighted price indices for material.

4. Importance of two digit industry

4.1 Relative importance of two-digit industries: Aggregate study

In table 1, it is observed that the average share of twelve selected industries in total manufacturing gross output is 80.55 % in pre-reform period. But the average share has increased to 82.28% in post reform period. During the entire study period 1980-81 to 2009-10, the average share (annual) of theses twelve industries in aggregate manufacturing gross output is 80.55% . While the average share of the remaining 11 two-digit industries defined as 'Others' decreased from 19.45% in pre-reform to 17.72% in post reform period shown in table 1.

In case of net value added, it is observed that the average share of twelve selected industries in total manufacturing is 72.98 % in pre-reform period. But the average share has increased to 79.76% in post reform period. During the entire study period 1980-81 to 2009-10, the average share (annual) of theses twelve industries in aggregate manufacturing gross output is 72.98% (table 1). Where as the average share of the remaining 11 two-digit industries defined as 'Others' decreased from 27.02% in pre-reform to 20.24% in post reform period shown in table 1.

The share of labour in twelve selected industries in total manufacturing is 72.78% during entire period of study, shown in table1. The share of labour has increased from 72.78% to 73.76% from the period pre-reform post –reform period. But labour share of 'others' has declined from 27.22% to 26.24 % from pre-reform to post -reform period. (table2)

Table 1, shows that the average shares of fixed capital of twelve selected industries in total manufacturing is 51.81% during entire period of study. However the average share of fixed capital has increased from 51.81% to 76.47% from pre-reform to post –reform period. But the share of 'others' has declined from 48.19% to 23.53 % from pre-reform to post -reform period. (table2).

Therefore the figures of variables in table 1, indicate that the importance of selected twelve industries has increased where as the importance of 'others' has declined in Indian manufacturing.

4.2 Relative positions of selected industries in aggregate manufacturing during the period 1980-81 to 2009-10: Disaggregated study

In table 1, the relative position of different two-digit industries in Indian manufacturing industry has been shown in terms of different macro variables.

Net value added : During the entire period of study, among the twelve industries it would be seen that the prime position in respect of share of net value added (annual average) is occupied by Chemicals and chemical products accounted for 15.18%, followed by Basic metals (11.46%), Textiles products (8.87%), Food products & beverages (8.58%), Coke, petroleum products and nuclear fuel (6.05%), Machinery & equipments n.e.c (5.85%), Non-metallic mineral products (4.51%), Electrical machinery and apparatus n.e.c. (4.39%), Motor vehicles, trailers and semi trailers (4.31%), other transport equipments (2.93%), Rubber and plastic products (2.71%) and Fabricated metal products respectively (4.02%) respectively.

Gross output: The industry with maximum share of gross output out (annual average) is Food products & beverages accounted for 13.97% followed by Chemicals and chemical products (13.50%), Basic metals (12.14%), Textiles products (9.48%), Coke, petroleum products and nuclear fuel (9.22%), Machinery & equipments n.e.c (4.62%), Motor vehicles, trailers and semi trailers (4.15%), Electrical machinery and Apparatus n.e.c (3.58%) Non-metallic mineral products (3.36%), Rubber and plastic products (2.89%), other transport equipments (2.49%), and Fabricated metal products (2.24%) respectively.

Labour: During the period of study, the largest employment generating industry in aggregate manufacturing is Textiles products contributed to 16.52% share (annual average) in aggregate manufacturing , followed by Food products & beverages (14.79%), Chemicals and chemical products (8.08%), Basic metals (7.47%), Non-metallic mineral products (5.60%), Machinery & equipments n.e.c (5.22%), other transport equipments (3.19%), Electrical machinery and Apparatus n.e.c (3.12%), Fabricated metal products (3.08%), Motor vehicles, trailers and semi trailers (2.92%), Rubber and plastic products (2.89%), and Coke, petroleum products and nuclear fuel (2.85%) respectively.

5. Growth rate of output, inputs and factor shares

5.1 Growth rate of output and inputs

It is noted from the table (2) that there is a positive growth in net value added and gross output for all two digit industries during the entire period of study. The maximum growth of net value added and gross output is observed in Rubber and plastic products and Motor vehicles, trailers and semi trailers respectively.

In case of factor input growth, there is a positive growth of capital and materials for all two digit industries during the period 1980-81 to 2009-10, and the maximum growth of capital is observed in Coke, petroleum products and nuclear fuel , while maximum growth of materials is observed in Motor vehicles, trailers and semi trailers industry.

During the period 1980-81 to 2009-10, there is a positive growth of labour observed for all industries except Textile products and other transport equipments industry while it is positive for all India aggregate manufacturing

5.2 Trend growth rate of factor shares

Table (3) shows that, during the period of study, there is a negative growth of labour share observed in all two digit industries including all India manufacturing.

In case of share of capital, the positive trend growth is observed in seven industries out of thirteen industries shown in table . The positive trend growth of share of materials is observed in eight industries out of thirteen industries.

6. Methodology for estimating total factor productivity

Here we discuss the estimation of total factor productivity (TFP) growth. Partial factor productivity is calculated by dividing the total output by the quantity of an input. Hence labour productivity is (Y/L), capital productivity is (Y/K) and material productivity is (Y/M). Where Y is the real gross output, L, K, M indicate labour, capital and materials respectively. But this measure of partial factor productivity has well-known limitations since it ignores the fact that productivity of an input also depends upon the level of other inputs used. In situations where capital intensity is increasing over time, partial productivity measures such as labour productivity may show an increase but this may be due to increase in capital-labour ratios rather than pure productivity increases. These problems can be resolved by analyzing total factor productivity growth which identifies the contribution to an increase in output of influences other than increases in the factor inputs. Total factor productivity growth means not only the effects of technical progress but also of better utilization of capacities, learning-by-doing, improved skills of labour, etc. It is therefore a composite measure of technological change and changes in the efficiency with which known technology is applied to production.

There are different major approaches to productivity measurement, viz index number, econometric and non parametric (Diewert 1980; Christensen 1980). In index number approach there is a scope to us to include any number of inputs and does not require a long data series (Diewert 1980). The problems of multi-co linearity, autocorrelation which often poses serious challenge in econometric estimation, can be avoided in index number approach. In growth accounting approach, the TFP growth is measured by subtracting the weighted input growth from output growth. The difference of weighted input growth from output growth includes the effect of technical progress, scale of production, learning by doing, technical efficiency etc. There are various approaches within the growth accounting approach for estimating TFP growth. The growth accounting measure of translog index (instead of Kendrick Index or Slow Index) is used in this study on the basis of discrete approximation of the tranlog index although it requires the imposition of restrictive assumptions of constant returns to scale and Hicks Hicks-neutral technical progress. Admittedly the methodology for estimating total factor productivity growth has limitations but it certainly provides a useful supplement to the conventional analysis of the trends in partial productivity measures and TFP growth of Indian manufacturing has been estimated by using this approach in most of the recent studies.

For the estimation of TFP growth there is also a problem whether the output is taken as a Value added form or a Gross output form. In value added function, it is implicitly assumed that the primary and intermediate inputs are separable in the underlying production function. Unfortunately, Indian industries do not satisfy the requirements of separability conditions (William and Laumas 1982). Hence output, instead of value added, appears to be more appropriate choice for TFP growth estimation for India.

For a Gross output approach with three inputs case, the Translog Index can be defined as follows:

$$\Delta \ln TFP(t) = \Delta \ln Y(t) - [\{SL(t) + SL(t-1)\}/2 \times \Delta \ln L(t)] - [\{SK(t)+SK(t-1)\}/2 \times \Delta \ln K(t)] - [\{SM(t) + SM(t-1)\}/2 \times \Delta \ln M(t)]$$

In the above equation, Y denotes Gross output, L, K, and M represent labour, capital and materials respectively. SL, SK, and SM are shares of labour, capital, and materials respectively. The sum of all shares is equal to unity. Δ lnTFP is the rate of growth of total factor productivity.

Using the above equation, the growth rates of TFP have been computed for each year. If A is considered the index of TFP .The index for the base period, A(0), is taken as 100. Then the index for subsequent years is estimated using the following equation: $A(t) = \exp[\Delta \ln TFP(t)]\, A(t-1)$

7. Empirical Findings

7.1 Total factor productivity growth

The estimates of total factor productivity growth in the aggregate manufacturing is shown in table 4. The table is made to compare TFP estimates between sub periods as well as different studies. It is noticed from the table that the TFP growth for the period 1981-82 to 1990-91 is 1.30 percent per annum while it is 1.18 percent during the period 1991- 92 to 2009-10. That means there is a clear indication of a fall in TFP growth in post reform as compared to pre reform period. This finding of a decline in TFP growth in Indian manufacturing in the 1990s is also observed in Trivedi et al. (2000) and Golder and Kumari (2003) study shown in table . During the period 1990- 91 to 1997-98, the TFP growth in all India manufacturing is observed 0.26 per cent per annum in this study while it is observed 0.63 percent and 0.69 percent per annum in Trivedi et.al.(2000) and Golder and Kumari (2003) study respectively.

For the entire period 1981-82 to 2009-2010, the growth rate of TFP in Indian manufacturing is estimated at 1.22 percent per annum. Now why did TFP growth in Indian manufacturing decelerate in the post reform period? One possible explanation was gestation lags according to Uchikawa[#]. There was a spurt in investment activity in the 1990s in response to economic reforms and this huge investment leads to under utilization of capacity in the 1990s. So in this study, the entire post reform period is subdivided in to three different sub periods and compares the TFP growths. It is done to observe whether the TFP growth increases in recent periods in Indian manufacturing. For first sub period the TFP growth is 0.26 per cent per annum. The TFP growth in second sub period is negative (-0.11 percent) and for the third sub period it is positive (2.62 percent per annum) and greater than the first sub period. Therefore it can be said that TFP growth in Indian manufacturing increases in the recent periods.

Total factor productivity growth for two digit industries are shown in table 5. The estimated growth are positive for all the manufacturing industries during the period 1980-81 to 2009-10 except Food products & beverages and Coke, petroleum products and nuclear fuel. In most cases The growth rate of all two digit industries is higher in pre reform period compare to post reform period except Coke, petroleum products and nuclear fuel and Fabricated metal products. This is the reasons of decreasing in TFP growth in Indian manufacturing in the post reform period compare to the pre reform period.

7.2 Sources of output growth

Here in this study the main sources of output growth are labour, capital , materials and TFPG (total factor productivity growth). For aggregate manufacturing, it is observed from the table 6 that labour, capital, materials contribute 0.61%, 8.77% and 76.19% respectively to the total output growth where as TFPG contributes 14.33% to the output growth. .In case of all two digit manufacturing industries it is observed that material contributes maximum to output growth. Therefore it can be said that output growth is driven by input growth rather than TFP growth in Indian manufacturing. If we look at the pre reform and post reform periods the same picture are shown in table 7 and table 8 respectively.

8. Conclusion

This study has shown that the there was a deceleration in TFP growth in the 1990s as compared to the 1980s. This is corroborated by the TFP estimates presented by the studies of Balakrishnan, Pushpangadan and suresh Babu (2000) , Trivedi et al., (2000) and Golder and Kumari (2003). But the rate of fall in TFP growth in this study is greater than the other similar studies mentioned above. They used price indices with base 1993-94=100 while in this study 2004-2005= 100 is used for base year. The TFP growth in Indian manufacturing decelerated in 1990s reflected many studies including this due to spurt in investment activity in the 1990s in response to economic reforms, and hence to gestation lags then it is expected the growth rate of TFP will increase in coming years. The TFP growth in recent period i.e. increases which confirms the expectation. If we look at the sources of output growth then it is observed that output growth is driven by input growth mainly materials rather than TFP growth in Indian manufacturing.

References

1. Ahluwalia, I.J. (1985), Productivity Growth in India Delhi: Oxford University Press.
2. Ahluwalia, I.J. (1991), Productivity and Growth in Indian manufacturing Delhi: Oxford University Press.
3. Balakrishnan, Pulapre, and K. Pushpangadan (1994), "Total Factor-Productivity Growth in Manufacturing Industry: A Fresh Look." Economic and Political Weekly, Vol. 29, No. 31, pp. 2028–3.
4. -------- (1998),"What Do We Know about Productivity Growth in Indian Industry," Economic and Political Weekly Vol. 33, pp.2241-46.
5. -------- (2002). "TFPG in Manufacturing: The 80s Revisited." Economic and Political Weekly Vol. 37, No. 4, pp. 323–25.
6. Balakrishnan, P., K. Pushpangadan and M. Suresh Babu (2000), "Trade Liberalisation and Productivity Growth in Manufacturing: Evidence from Firm-level Panel Data," Economic and Political Weekly Vol. 35, No.41, pp.3679-82.
7. Balakrishnan, P. and M. Suresh Babu (2003), "Growth and Distribution in Indian Industry in the Nineties," Economic and Political Weekly, Vol.38, pp. 3679-82.
8. Banga, Rashmi and Bishwanath Goldar (2004), "Contribution of Services to Productivity Enhancement and Growth in Indian Manufacturing: Pre and Post Reform Period,

Working

Paper, Indian Council for Research on International Economic Relations, New Delhi.

9. Charles R. Hulten (1979), On the "Importance" of Productivity Change, The American Economic Review, March, Vol.69, No. 1, pp. 126-136.
10. Das, Deb Kusum (2003), "Manufacturing Productivity under Varying Trade Regimes: India in the 1980s and 1990s", Working Paper No.107, Indian Council for Research on International Economic Relations, New Delhi.
11. Dholakia RH, Dholakia BH (1994), 'Total factor productivity growth in Indian manufacturing', Economic Political Weekly, Vol. 29, pp. 342-344.
12. Goldar, B. N (2000), "Employment Growth in Organized Manufacturing in India", Economic and Political Weekly, April 1, pp 1191-95.
13. -------(2000a), "TFP Growth in the Indian Manufacturing in the 1980s", Economic and Political Weekly Vol.37, No. 49, pp. 4966-68.
14. -------(2002), "TFP Growth in the Indian Manufacturing in the 1980s", Economic and Political WeeklyVol. 37, No.49, pp. 4966-68.
15. -------(2004), "productivity trends in Indian Manufacturing in the Pre-and Post-Reform periods'' working paper no.137, Indian Council for Research on International Economic Relations, New Delhi
16. Goldar, Bishwanath and Anita Kumari (2003), "Import Liberalization and Productivity Growth in Indian Manufacturing Industries in the 1990s", Developing Economics, December, Vol.41, No.4, pp. 436-60.
17. Goldar, Bishwanath and Arup Mitra (2002), "Total Factor Productivity Growth in Indian Industry: A Review of Studies", in B.S. Minhas (edited), National Income Accounts and Data Systems, Delhi: Oxford University Press.
18. Hasim,S.R and M.M. Dadi (1973), Capital-output Relations in Indian Manufacturing (1946-64), Baroda: M.S. University of Baroda.
19. Hulten, C (1978), "Growth Accounting with Intermediate Inputs", Review of Economic Studies, Vol. 45, pp 511-18.
20. Jorgenson, DW and Z. Grilliches (1967), "The Explanation of Productivity Change", Review of Economic Studies, Vol.34, pp. 249-83.

21. Pradhan G. and K. Barik (1999), "Total Factor Productivity Growth in Developing Economies: A Study of Selected Industries in India", Economic and Political Weekly, Mumbai, July 31.
22. Rao, J.M. (1996), "Manufacturing Productivity Growth: Method and Measurement," Economic and Political Weekly, November, Vol.2, No. 31 pp.2927-36.
23. Ray, S.C. (1997), "Regional Variation in Productivity Growth in Indian Manufacturing: A Non-parametric Analysis" Journal of Quantitative Economics, Vol.13, pp. 73-94.
24. ------- (2002), "Did India's economic reforms improve efficiency and productivity? A nonparametric analysis of the initial evidence from manufacturing", Indian Economic Review, Vol.37, pp.23-57.
25. Solow, R M (1957), "Technical Change and the Aggregate Production Function", Review of Economics and Statistics, Vol. 39, pp 312-20.
26. Srivastava, Vivek (1996), "Liberalization, Productivity and Competition": A Panel Study of Indian Manufacturing," Delhi: Oxford University Press.
27. Srivastava Vivek, Pooja Gupta and Arindam Datta (2001), "The Impact of India's Economic Reforms on Industrial Productivity, Efficiency and Competitiveness": A Panel Study of Indian Companies, 1980-97, Report, National Council of Applied Economic Research, New Delhi.
28. Suresh Babu, M (2001): "Competition, Productivity and Barriers to Entry in Indian Manufacturing", Centre for Development Studies, unpublished doctoral dissertation, Thiruvananthapuram
29. Tata Services Limited (2003), "Reforms and Productivity Trends in Indian Manufacturing Sector", Department of Economics and Statistics Tata Services Limited, Mumbai
30. Trivedi, P., A. Prakash, and D. Sinate (2000), "Productivity in Major Manufacturing Industries in India: 1973-74 to 1997-98," Development Research Group Study no. 20, Department of Economic Analysis and Policy, Reserve Bank of India, Mumbai.
31. Unel, Bulent (2003), "Productivity Trends in India's Manufacturing Sectors in the last Two Decades", IMF Working Paper no. WP/03/22
32. Unni,Jeemol.,Lalitha,N.,and Rani, Uma (2001), "Economic Reforms and Productivity Trends In Indian Manufacturing", Economic and Political weekly, Vol.36, No. 41, pp. 3914-3922.

33. W. E. Diewert (1980), "Capital and the Theory of Productivity Measurement", The American Economic Review, May, Vol.70, No. 2, pp. 260-267.

Appendix: A

Measurement of Capital Stock

Gross fixed Capital stock at 2004-05 prices is taken as the measure of capital input. This has been computed for both aggregate manufacturing and individual two digit industries in the following way:

I) Aggregate manufacturing sector: An estimate of net fixed capital stock for the registered manufacturing sector for end –March 1971 (benchmark) is taken from National Accounts Statistics (NAS)[1]. This is multiplied by a gross-net factor to get an estimate of gross fixed capital stock for the year 1970-71. The ratio of gross to net fixed assets in medium and large public limited companies (as reported in Reserve Bank of India Bulletin) was 1.86 in 1970-71. Thus, the net fixed capital stock for registered manufacturing for the benchmark year, reported in NAS, is multiplied by 1.86 to get an estimate of gross fixed capital stock for the benchmark year. To build the capital stock series from the benchmark capital stock estimate, the perpetual inventory method is used. Thus, gross investment in fixed assets in registered manufacturing in 1971-72 is added to the benchmark capital estimate (1970-71) to obtain the capital stock estimate for the next year, i.e., end-March 1972. In this manner, the entire capital stock series for the successive years is built. The gross fixed investment[2] series is computed by subtracting the book value of fixed capital of previous period from the value of current year and then adding current year depreciation to it. In preparing the time series on capital stock, it is important to allow for discarding of assets (Golder 1992). The rate of discarding has been taken as 5 percent per annum which is used many similar studies like Unel 2003, Golder and Banga 2004 etc.

II) Two digit industries: The benchmark estimate of gross fixed capital stock made for registered manufacturing for 1970-71 is distributed among various two-digit industries in proportion of their net fixed capital stock to the fixed capital stock (net) of aggregate manufacturing, reported in ASI, 1970-71. This provides the benchmark capital stock estimates for individual two digit industries. Then, for each industry and for each year, gross investment at current prices are computed, taking the difference in the book value of fixed capital assets reported in ASI and added the depreciation. In this manner the series of Gross investment at current prices is obtained for each two digit industry for each year from 1971-72 to 2009-2010. The series of gross

investment at current prices is deflated by implicit capital price deflator to make it real series of gross investment. Then, following the perpetual inventory method, the time series on gross fixed capital stock has been constructed for all nine two digit industries. In this case again, the rate of discarding is taken as 5 percent per annum, to be consistent with the capital series for aggregate manufacturing.

Table1. Average share (percentage) of variables of two digit Indian manufacturing industries during the period 1980-81 to 2009-2010

	Pre reform period				Post reform period				Overall period			
NIC 2004	L	K	NVA	Y	L	K	NVA	Y	L	K	NVA	Y
15	14.44	4.22	8.39	13.97	15.00	6.79	8.69	13.97	14.79	5.85	8.58	13.97
17	18.83	6.11	11.90	11.30	15.19	8.57	7.12	8.43	16.52	7.67	8.87	9.48
23	0.65	2.39	3.46	8.09	0.86	6.43	7.54	9.87	2.81	4.95	6.05	9.22
24	7.06	10.92	12.36	13.13	8.67	15.77	16.81	13.71	8.08	13.99	15.18	13.50
25	1.79	1.31	2.47	2.59	3.10	2.92	2.85	3.07	2.89	2.33	2.71	2.89
26	5.29	3.91	4.04	3.35	5.77	6.22	4.78	3.36	5.60	5.37	4.51	3.36
27	7.94	14.13	10.46	12.12	7.19	17.97	12.04	12.16	7.47	16.56	11.46	12.14
28	2.42	0.83	2.12	1.93	3.47	1.57	2.60	2.42	3.08	1.30	2.43	2.24
29	4.68	2.25	5.67	4.41	5.52	2.91	5.95	4.75	5.22	2.66	5.85	4.62
31	3.41	1.72	5.08	4.04	2.94	1.86	3.99	3.32	3.12	1.81	4.39	3.58
34	2.24	1.76	3.86	3.09	3.32	4.05	4.58	4.77	2.92	3.21	4.31	4.15
35	4.01	2.28	3.17	2.55	2.72	1.40	2.79	2.45	3.19	1.72	2.93	2.49
sum	72.78	51.81	72.98	80.55	73.76	76.47	79.76	82.28	75.70	67.43	77.28	81.64
others	27.22	48.19	27.02	19.45	26.24	23.53	20.24	17.72	24.30	32.57	22.72	18.36

According to NIC code 2004, the code of the two digit industries given below:

Food products & beverage 15, Textiles products 17, Coke, Petroleum products and neuclear fuel 23, Chemicals & chemical products 24, Rubber and Plastic Products 25, Non-metallic Mineral products 26, Basic Metals 27, Fabricated metal Products 28, Machinery & equipments n.e.c 29, Electrical Machinery and Appratus n.e.c 31, Motor Vehicles, trailers and semi trailers 34, Other Transport equipments 35, 'others' (remaining 11 two-digit industries).

Table 2 . Annual average growth (percentage) of variables in Indian manufacturing industries during the period 1980-81 to 2009-2010

Selected Industry	NIC 2004 code	Gross output	Labour	Capital	Materials	Value added
Food products & beverages	15	7.11	0.72	6.33	7.66	7.58
		(6.75)	(0.99)	(6.71)	(7.16)	(6.32)`
Textiles products	17	7.23	-0.29	6.28	6.97	5.83
		(7.08)	(-0.51)	(6.69)	(6.45)	(5.39)
Coke, Petroleum products and neuclear fuel	23	9.32	4.32	10.10	10.29	20.00
		(7.55)	(2.74)	(10.23)	(7.78)	(10.74)
Chemicals & chemical products	24	8.61	2.14	5.51	8.34	9.57
		(8.02)	(2.10)	(6.03)	(8.14)	(8.35)
Rubber and Plastic Products	25	12.20	5.05	9.63	10.46	12.81
		(11.46)	(4.44)	(10.21)	(10.18)	(10.77)
Non-metallic Mineral products	26	9.24	3.07	9.12	9.47	11.12
		(8.19)	(1.81)	(9.11)	(8.30)	(8.58)
Basic Metals	27	8.49	1.94	5.46	8.44	9.13
		(7.30)	(0.47)	(5.55)	(7.34)	(7.22)
Fabricated metal Products	28	9.92	4.15	8.21	9.70	10.03
		(9.78)	(3.54)	(7.79)	(9.20)	(6.31)
Machinery & equipments n.e.c	29	10.21	3.92	5.27	9.37	9.94
		(8.83)	(1.64)	(4.79)	(8.62)	(7.74)
Electrical Machinery and Appratus n.e.c	31	10.40	8.38	5.39	8.31	10.35
		(9.11)	(0.56)	(5.57)	(7.33)	(7.98)
Motor Vehicles, trailers and semi trailers	34	14.58	4.90	10.10	14.38	13.34

		(12.32)	(3.80)	(9.87)	(12.29)	(10.15)
Other Transport equipments	35	9.84 (8.55)	-1.07 (-2.22)	4.52 (4.38)	9.54 (8.66)	9.63 (6.94)
Others manufacturing		9.71 (6.76)	2.03 (0.37)	3.15 (3.17)	10.36 (7.37)	8.19 (4.15)
All India aggregate manufacturing		9.01 (8.14)	1.41 (0.85)	4.94 (4.98)	8.75 (8.14)	8.35 (7.20)

Note: Figures in parenthesis indicate trend growth rate (percent) of the concerned variables.

Table 3 . Annual average growth (percentage) of factor share in Indian manufacturing industries during the period 1980-81 to 2009-2010

Selected Industry	SL	SK	SM
Food products & beverages	-1.14	1.94	-0.01
	(-1.87)	(0.26)	(0.06)
Textiles products	-2.44	1.09	0.49
	(-3.48)	(0.47)	(0.26)
Coke, Petroleum products and neuclear fuel	0.92	9.65	-0.16
	(-1.90)	(3.20)	(-0.29)
Chemicals & chemical products	-0.70	1.59	-0.11
	(-1.84)	(0.99)	(-0.10)
Rubber and Plastic Products	-0.81	1.63	0.02
	(-1.54)	(-0.22)	(0.16)
Non-metallic Mineral products	-2.05	3.38	-0.31
	(-2.46)	(1.49)	(-0.19)
Basic Metals	-2.14	2.64	0.20
	(-3.40)	(1.27)	(0.01)
Fabricated metal Products	-1.34	1.33	0.09

	(-2.20)	(0.08)	(0.22)
Machinery & equipments n.e.c	-0.91	0.36	0.17
	(-2.29)	(-0.24)	(0.36)
Electrical Machinery and Appratus n.e.c	-0.62	0.55	0.17
	(-2.63)	(-0.41)	(0.34)
Motor Vehicles, trailers and semi trailers	-1.92	1.64	0.41
	(-3.98)	(-0.97)	(0.57)
Other Transport equipments	-4.25	4.01	0.61
	(-5.84)	(2.22)	(0.57)
Others manufacturing	-2.38	-0.35	1.36
	(-4.04)	(-1.54)	(0.80)
All India aggregate manufacturing	-2.39	0.51	0.19
	(-3.50)	(0.34)	(0.23)

Note: Figures in parenthesis indicate trend growth rate (percent) of the concerned variables.

Table 4. Total factor productivity growth (%) in Indian manufacturing during the period 1981-82 to 2009-2010

	Period	This study	Golder study	Trivedi study
Pre reform period	Period 1981-82 to 1990-91	1.30	1.89	1.26
Post reform period	Period 1990 -91 to 1997-98	0.26	0.69	0.63
overall period	period 1981-82 to 1997-98	1.22	1.40	1.00
post reform period	Period 1991 -92 to 2009-10	1.18		
Sub period 1	Period 1991 -92 to 1997-98	0.26		
Sub period 2	Period 1998 -99 to 2001-02	-0.11		
Sub period 3	Period 2002-03 to 2009-10	2.62		
Overall period	Period 1981-82 to 2009-10	1.22		

Table 5. Total factor productivity growth in Indian manufacturing two-digit industries during the period 1981-82 to 2009-2010

Selected Industry	NIC 2004 code	Pre reform	Post reform	Over all period
Food products & beverages	15	0.0006	-0.0029	-0.0017
Textiles products	17	0.0021	0.0145	0.0102
Coke, Petroleum products and neuclear fuel	23	-0.0244	0.0006	-0.0080
Chemicals & chemical products	24	0.0258	0.0024	0.0105
Rubber and Plastic Products	25	0.0071	0.0270	0.0201
Non-metallic Mineral products	26	0.0073	0.0003	0.0027
Basic Metals	27	0.0075	0.0071	0.0072
Fabricated metal Products	28	-0.0054	0.0140	0.0073

Machinery & equipments n.e.c	29	0.0230	0.0150	0.0178
Electrical Machinery and Appratus n.e.c	31	0.0284	0.0239	0.0255
Motor Vehicles, trailers and sem itrailers	34	0.0213	0.0079	0.0125
Other Transport equipments	35	0.0230	0.0173	0.0193
Others manufacturing		0.0177	0.0102	0.0128
All India aggregate manufacturing		0.0131	0.0118	0.0122

Note: Author's own calculation based on ASI data.

Table 6. Sources of Output growth in Indian manufacturing industries during the period 1981-82 to 2009-2010

Selected Industry	NIC 2004	Δ ln Y	[SL(t)+SL(t-1)/2]*Δ lnL	[SK(t)+SK(t-1)/2]*Δ lnK	[SM(t)+SM(t-1)/2]*Δ ln M	TFP Gowth
Food products & beverages	15	0.067	0.0001	0.006	0.062	-0.002
			(0.18)	(8.57)	(93.73)	(-2.48)
Textiles products	17	0.066	-0.001	0.007	0.050	0.010
			(-1.53)	(10.55)	(75.61)	(15.38)
Coke, Petroleum products and neuclear	23	0.078	0.000	0.010	0.076	-0.008
			(0.44)	(12.64)	(97.21)	(-10.29)
Chemicals & chemical products	24	0.081	0.001	0.011	0.059	0.010
			(1.29)	(13.09)	(72.65)	(12.96)
Rubber and Plastic Products	25	0.113	0.003	0.014	0.077	0.020
			(2.24)	(12.00)	(67.92)	(17.84)
Non-metallic Mineral products	26	0.085	0.002	0.019	0.061	0.003
			(2.24)	(22.52)	(72.08)	(3.16)
Basic Metals	27	0.077	0.000	0.008	0.061	0.007
			(0.46)	(10.80)	(79.38)	(9.36)
Fabricated metal Products	28	0.090	0.003	0.011	0.069	0.007
			(2.94)	(12.29)	(76.60)	(8.17)
Machinery & equipments n.e.c	29	0.091	0.002	0.008	0.064	0.018
			(1.87)	(8.91)	(69.76)	(19.45)
Electrical Machinery and Appratus n.e.c	31	0.092	0.001	0.009	0.057	0.025
			(0.89)	(9.44)	(61.96)	(27.72)

Motor Vehicles, trailers and semi itrailers	34	0.119	0.003 (2.25)	0.014 (11.83)	0.090 (75.40)	0.013 (10.51)
Other Transport equipments	35	0.087	-0.002 (-2.80)	0.006 (6.45)	0.065 (74.24)	0.019 (22.12)
Others manufacturing		0.084	0.001 (1.06)	0.006 (6.99)	0.064 (76.70)	0.013 (15.25)
All India aggregate manufacturing		0.085	0.001 (0.61)	0.007 (8.77)	0.064 (76.19)	0.012 (14.43)

Note: Figures in bracket indicate the percentage contribution of the corresponding input in total output growth.

Table 7. Sources of Output growth in Indian manufacturing industries during pre reform period

Selected Industry	NIC 2004	Δ ln Y	[SL(t)+SL(t-1)/2]*Δ lnL	[SK(t)+SK(t-1)/2]*Δ ln K	[SM(t)+SM(t-1)/2]*Δ ln M	TFP Gowth
Food products & beverages	15	0.074	-0.001 (-1.03)	0.004 (6.02)	0.069 (94.15)	0.001 (0.86)
Textiles products	17	0.060	-0.003 (-4.52)	0.005 (8.92)	0.055 (92.13)	0.002 (3.47)
Coke, Petroleum products and neuclear fuel	23	0.077	0.0003 (0.43)	0.004 (5.35)	0.097 (125.93)	-0.024 (-31.71)
Chemicals & chemical products	24	0.098	0.0003 (0.27)	0.006 (6.35)	0.066 (67.14)	0.026 (26.24)
Rubber and Plastic Products	25	0.105	0.002 (2.29)	0.013 (11.92)	0.083 (79.03)	0.007 (6.76)
Non-metallic Mineral	26	0.095	0.002	0.020	0.066	0.007

products						
			(2.03)	(21.10)	(69.23)	(7.65)
Basic Metals	27	0.072	0.000	0.003	0.061	0.007
			(0.46)	(4.28)	(84.93)	(10.34)
Fabricated metal Products	28	0.062	0.002	0.007	0.059	-0.005
			(3.01)	(10.92)	(94.80)	(-8.73)
Machinery & equipments n.e.c	29	0.097	0.004	0.007	0.063	0.023
			(3.77)	(7.48)	(65.06)	(23.69)
Electrical Machinery and Appratus n.e.c	31	0.067	-0.001	0.006	0.034	0.028
			(-1.53)	(8.26)	(50.84)	(42.42)
Motor Vehicles, trailers and sem itrailers	34	0.100	0.001	0.009	0.067	0.021
			(1.48)	(9.42)	(67.66)	(21.44)
Other Transport equipments	35	0.086	-0.005	0.004	0.064	0.023
			(-5.34)	(4.50)	(74.10)	(26.74)
Others manufacturing		0.094	0.001	0.006	0.069	0.018
			(1.20)	(6.11)	(73.84)	(18.84)
All India aggregate manufacturing		0.083	-0.00005	0.005	0.065	0.013
			(-0.06)	(6.46)	(77.85)	(15.74)

Note: Figures in bracket indicate the percentage contribution of the corresponding input in total output growth

Table 8. Sources of Output growth in Indian manufacturing industries during post reform period

Selected Industry	NIC 2004	Δ ln Y	[SL(t)+SL(t-1)/2]*Δ ln L	[SK(t)+SK(t-1)/2]*Δ ln K	[SM(t)+SM(t-1)/2]*Δ ln M	TFP Gowth
Food products & beverages	15	0.063	0.001	0.006	0.059	-0.003

			(0.93)	(10.14)	(93.47)	(-4.54)
Textiles products	17	0.070	-0.0001	0.008	0.048	0.015
			(-0.18)	(11.29)	(68.13)	(20.77)
Coke, Petroleum products and neuclear	23	0.079	0.000	0.013	0.065	0.001
			(0.44)	(16.39)	(82.43)	(0.74)
Chemicals & chemical products	24	0.072	0.001	0.013	0.055	0.002
			(2.03)	(17.95)	(76.63)	(3.39)
Rubber and Plastic Products	25	0.117	0.003	0.014	0.073	0.027
			(2.21)	(12.03)	(62.67)	(23.08)
Non-metallic Mineral products	26	0.080	0.002	0.019	0.059	0.000
			(2.37)	(23.42)	(73.88)	(0.34)
Basic Metals	27	0.079	0.000	0.011	0.061	0.007
			(0.46)	(13.92)	(76.73)	(8.89)
Fabricated metal Products	28	0.104	0.003	0.013	0.074	0.014
			(2.91)	(12.72)	(70.89)	(13.48)
Machinery & equipments n.e.c	29	0.088	0.001	0.009	0.064	0.015
			(0.77)	(9.74)	(72.48)	(17.00)
Electrical Machinery and Appratus n.e.c	31	0.105	0.002	0.010	0.069	0.024
			(1.70)	(9.83)	(65.70)	(22.77)
Motor Vehicles, trailers and sem itrailers	34	0.129	0.003	0.017	0.102	0.008
			(2.57)	(12.81)	(78.53)	(6.09)
Other Transport equipments	35	0.088	-0.001	0.007	0.065	0.017
			(-1.49)	(7.45)	(74.31)	(19.73)

Others manufacturing		0.079	0.001 (0.97)	0.006 (7.54)	0.062 (78.49)	0.010 (13.00)
All India aggregate manufacturing		0.085	0.001 (0.96)	0.008 (9.95)	0.064 (75.33)	0.012 (13.76)

Note: Figures in bracket indicate the percentage contribution of the corresponding input in total output growth.