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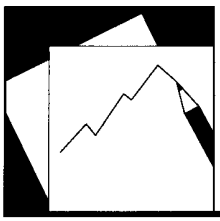

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J-Curve of Productivity and Growth: Indian Manufacturing Post-Liberalization

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Abstract

Most estimates of Indian manufacturing productivity find a slowdown in the 1990s. This has puzzled analysts, given that 1990s reforms were deeper and wider than the 1980s reforms that raised the growth rate of the Indian economy by 2 per cent points. This paper tests the hypothesis of the J curve of Productivity and Growth following major liberalization and finds it to be broadly supported by the data: Technological obsolescence, gradual adoption of new technology and learning by doing result in negative effects on measured productivity.

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I. Introduction

India moved from a growth rate of 3.5 per cent per annum during 1950/51 to 1979/80 to a growth rate of about 5.5 per cent per annum during the 1980s because of gradual trade and industrial liberalization and possibly fiscal expansion. Following the BOP crisis of 1990-1991, India undertook a deep and wide ranging liberalization of domestic and external policies. However, the growth rate barely moved from the 5.5-5.8 per cent range, during the 1990s [Virmani (2004, 2005a 2006b)].[1] Many analysts pointed to this puzzle: How could the limited reforms of the 1980s raise the growth rate of the Indian economy by 2 per cent points, while the relatively major reforms of the 1990s had virtually no measurable effect on the growth trend.

This has been mirrored in manufacturing, with an intense debate on the effects of economic reforms on productivity growth in Indian organized manufacturing. A majority of the studies have found that productivity growth in post reforms period of 1990s decelerated from growth rates seen in the 1980s.[2] This has baffled economists and policy analysts, as the reforms process was expected to accelerate productivity growth. Several studies have tried to provide an explanation for this unexpected outcome of the reforms process.

A few studies, instead of directly blaming the reforms for the slowdown, have held deteriorating capacity utilization responsible for the phenomena. They argued that owing to surge in investment activities and imports in the post reforms period, unaccompanied by commensurate expansion of demand, capacity utilization went on worsening in the manufacturing sector, thereby adversely affecting productivity growth [Uchikawa (2001); Goldar & Kumari (2003)]. Goldar & Kumari (2003) in their study provide numerous evidences of deteriorating capacity utilization in the 1990s. One piece of evidences they provide relates to the upward jump in the ratio of gross fixed capital formation to gross value added (at 1993/94 prices) in the organized manufacturing in the 1990s. According to them, the ratio was only 44 per cent during 1985-86 to 1989/90 but touched as high as 76 per cent during 1995/96 to 1997/98. The situation became worse from 1997 through 2001. The ratio of gross capital stock to gross value of output (at 1993-94 prices) increased from an average of 78.6 per cent between 1992/93 and 1997/98 to 83.7 per cent between 1998/99 and 2001-02. It, however, declined sharply to 61.2 per cent during 2002/03 to 2007/08. Thus, a correct comparison of productivity growth between 1980s and 1990s can be made only if the productivity growth is measured net of capacity utilization. Interestingly, even after adjusting for capacity utilization, Goldar & Kumari (2003) found that productivity growth in 1990s stayed at nearly the same level as during 1980s. But the question to answer remained as to why reforms failed to accelerate the productivity growth in the Indian manufacturing. In line with Athukorala & Rajapatirana (2000), they argued that such favorable productivity-enhancing effects of economic reforms may be manifested with a time lag and hence

[1] Alternatively see Virmani (2009) Chapter 1.

[2] See, for instance, Trivedi *et al*. (2000), Goldar (2000), and Goldar & Kumari (2003), Balakrishnan *et al*. (2000), Srivastava *et al*. (2001) and Das (2003).

expected an improvement in productivity growth in the years to come. However, this does not explain a decline in productivity during the reforms process.

Virmani (2009) showed that the pattern of productivity growth at macro level resulting from the 1990s reforms was in line with the prediction of the J-curve hypothesis (see appendix).[3] Estimates of productivity in Indian organized manufacturing by Virmani and Hashim (2009) and Hashim et. al. (2009) supported these conclusions within the limitations of data used. While the earlier study could provide the analysis for data up to 2001/02, the later study could not include the pre-reforms period of 1980s in the analysis.

The J curve has also been illustrated at an economy level by the experience of Eastern European countries and Russia after the fall of the Berlin wall Blanchard (1997), Kvintradze (2010). However, these countries were subjected to a systemic shock that transformed virtually the entire political-administrative system and fundamental economic institutions. The dramatic liberalization that followed complemented the decline in productivity and growth, but the conflation of the two may make it harder to separate the effects of institutional change from that of policy change.

The present study estimates productivity growth in Indian organized manufacturing industries with more up to date and comprehensive data for the manufacturing sector of the economy. It uses the data from 1981/82 to 2007/08 with a view to trace the changing impact of reforms on productivity and output growth. The data is broken up into two periods: The pre (1990s) reform period from 1981/82 to 1990/91 (Period I) and the reform / post-reform period from 1991/92 to 2007/08 (Period II). Based on the broad phases of varying levels of output growth and capacity utilization, the study breaks up the post reform period into following three sub-periods (SPs): Sub-period 1 from 1991/92 to 1997/98; Sub-period 2 from 1998/99 to 2001/02; and Sub-period 3 from 2002/03 to 2007/08. Productivity and output growth during the first or first two sub-periods is expected to be higher (lower) than in the later period/s if conventional S curve (J curve) effects predominate. We may also get a hybrid case in which the negative effects are slower to take effect than the positive conventional ones, so that we get an initial S-curve effect followed by a J curve one.

The rest of the paper is structured as follows: Section II summarizes the Modelling framework. Section III provides the sources of data and discusses construction of variables. This section also dwells on the trends in relevant variables of the manufacturing sectors; Section IV explains the methodology adopted for estimation of TFP; Section V presents the empirical findings; and the final Section provides the summary and broad conclusions of the study. The Appendix provides details of the J-curve hypothesis.

[3] Virmani (2009) Chapter 2.

II. Analytical Framework

Virmani (2005a, 2006a) proposed the hypothesis of the **J-curve of productivity and growth** following from major/large trade (import) liberalization (see appendix for details).[4] A gradual reform (consisting of a number of small or marginal steps in terms of theory) that occurred in India in the 1980s is expected to produce the conventional positive effect on productivity and growth, which may be called the **S curve of productivity and growth**.[5] In contrast (it was argued) a major liberalization of the kind that happened in India in the 1990s would lead to a structural transformation of the economy.[6] Due to the enormity of the change, the transition from the old globally inefficient structure to a new more efficient structure would be characterized by an initial slowdown in (measured) productivity and output growth. This would happen both in sectors and sub-sectors far from the global technology frontier and in the aggregate in the initial stages of transition. In later stage of transition, productivity and output growth would witness a surge. Decline in productivity and output growth immediately after reforms can mainly be linked to factors such as the deterioration in capacity utilization resulting from obsolescence of product lines and capital used to produce it (which would still be a part of measured capital), the gradual adoption and spread of new technology and the diversion of human resource for learning new technology and markets. Once the firms adjust to the new situation by appropriately developing the capacity, they start experiencing the rise in productivity and output growth. Businesses reap advantage of reforms gradually through learning by doing, exploitation of scale economies, R&D etc. The J-curve pattern of productivity and output growth in Indian manufacturing sector in post reforms period can also be linked to rigidity in labor laws, restricting businesses to realize immediate gains in productivity through reallocation of resources from one sector to another.

We can also get a **hybrid (S-J)** outcome in which the negative effects, that give rise to the J curve, are delayed for some sub-sectors/industries because of the sequence and/or time pattern of reforms, so that we get an initial rise in productivity (initial part of the S curve) followed by the J curve effect. For instance, there may be some reforms, such as removal of production and investment restrictions on the private sector, which yield quick payoffs in industries previously monopolized or dominated by the public sector (if the productivity differential strongly favors the former). Such productivity enhancing reforms may overwhelm, initially, the negative effects giving rise to the J curve. Note also that neither the conventional liberalization-reform argument(S-curve), nor the J curve hypothesis rule out declining productivity and growth of industries at a disaggregated level. There are bound to be some highly protected industries that are no longer viable at global prices of

[4] Bhalla (2007) relates aggregate growth fluctuations during the 1990s and 2000s to interest rates and exchange rates.

[5] In the context of growth theory, this could be viewed as moving from a lower to a higher growth rate through a spurt in growth.

[6] Alternatively, see Virmani (2009) Chapter 3.

products and mobile factors. These could show a declining pattern of productivity and growth with liberalization.

A. Pattern and Timing of Liberalization

In analyzing the J curve effect on sub-sectors of manufactures, the time pattern of liberalization has to be kept in mind. Access to dis-embodied technology and capital (FDI, equity and External Commercial Borrowing) was liberalized in the early 1990s followed by a more gradual opening of access to external long term debt. Import controls/Quantitative Restrictions on Intermediate and Capital goods were eliminated in the early 1990s, while the QRs on manufactured consumer goods were not eliminated till the end of the 1990s-early 2000s [Virmani (2003, 2005b)]. Though nominal tariff on consumer goods were reduced in line with those on other goods, the effective tariffs on consumer goods may actually have increased for much of the nineties because the remaining import restriction/QRs kept the effective tariff on final consumer goods high. Those consumer industries that used this period of protected profits to accelerate the introduction of new products using frontier technology and capital avoided any reduction in TFPG and may have accelerated it. Tariff reductions focused on reducing the peak or highest rate on all non-agricultural goods and were broadly proportional across the spectrum of goods, with a few notable exceptions. In the case of refineries, inputs on oil were deliberately maintained at a fraction of the average tariffs on the output of refineries, thus keeping effective protection high throughout the period. In the case of capital goods an effort was made to keep import duties on major identifiable inputs such as steel well below the average tariffs on capital goods. This has likely resulted in some capital goods having a higher effective protection in the early sub-periods, with gradual convergence to neutrality by the end of the last sub-period.

As most exports had access to duty free imports of intermediate inputs and lower tariffs on capital goods even before the 1990s reforms and can therefore be assumed to be globally competitive even before the 1990s reforms. They would tend to be relatively immune from the J curve effect. Their technology gap with global best practice would also be relatively low. In contrast the technology gap would be expected to be highest in highly protected industries and would tend to show strong J curve effect.

The second important dimension is that relating to the role of the **Public sector**. In several industries, such as steel, aluminum, and refineries, the public sector had an important share of pre 1990 reform production. These industries were also characterized by controls/restrictions on capacity creation and licensing of new investment that adversely affected the private sector. Liberalization of these controls and de-licensing allowed the private sector to raise its share of production, in some cases quite rapidly with minor investment in balancing equipment.[7] This would tend to raise the average productivity of the industry, if private efficiency was higher than that of the public sector. The same result

[7] It is also speculated that their actual capacity was higher than the licensed and declared capacity!

would follow from the privatization of loss making Public sector units. It is instructive to see how these factors played out at a disaggregated level.

III. Data and Variables

With a view to trace the changing impact of reforms on productivity and output growth, the present study uses the data for broad manufacturing sectors from 1980-81 to 2007-08. To understand the broad trends in variables in pre and post reforms period, the study period has been divided in two sub-periods: (a) Period I (1981/82 to 1990/91), and (b) Period II (1991/92 to 2007/08). In view of the fact that there has been wide variations in productivity and output growth in post reforms period as observed by Hashim et al (2010), Period II has been further sub-divided in three sub-period: (i) Sub-period 1 (1991/92 to 1997/98), Sub-period 2 (1998/99 to 2001/02) and Sub-period 3 (2002/03 to 2007/08).

The study uses two-digit level of ASI manufacturing industries. It excludes the following non-manufacturing sectors from the analysis: (i) Agriculture, hunting & related service activities, (ii) Other mining and quarrying, (iii) Recycling, and (iv) Other industries. Within manufacturing sector, the study focuses only on industries having an average share of more than 2% in the aggregate manufacturing output during the study period. On this basis, the following 12 industries comprising of 89.1% shares in output were selected for the analysis: (1) Food products & beverages (15.7%), (2) Chemicals & chemical products (14.6%); (3) Basic metals (13.1%); (4) Textiles products (10.2%); (5) Coke, petroleum products & nuclear fuel (9.6%); (6) Machinery & equipment n.e.c (4.6%); (7), Motor vehicles, trailers & semi-trailers (4.5%) ; (8) Electrical Machinery and Apparatus nec (3.7%); (9) Non-mettalic Mineral products (3.7%); (10) Rubber and Plastic products (3.2%); (11) Other Transport equipments (2.7%); and Fabricated metal products (2.7%). The remaining 10 two-digit industries, accounting for remaining 10.1% share in the aggregate manufacturing sector, were put together in a category defined as 'Others'. Category 'Others' includes: (i) Radio, television & communication equipments (1.8%); (ii) Paper & paper products (1.8%); (iii) Wearing apparel, dressing & dyeing of fur (1.3%); (iv) Tobacco & related products (1.2%); (v) Furniture & other manufacturing n.e.c. (1.2%); (vi) Leather & related products (1.1%); (vii) Publishing, printing & related activities (1.1%); (viii) Medical, precision & optical instruments (0.6%); (ix) Office, accounting & computing machinery (0.5%); and (x) Wood & wood products (0.3%).

A. Construction of variables and sources of data

In order to obtain the expenses on inputs at constant prices, their respective series at current prices are deflated with relevant price indices (1993/94=100). When exact deflators were not available, the best suitable proxies for the industry concerned were selected from the *WPI* series. The capital stock has been represented by the net fixed capital (at constant price). Following the usual practice, its series is constructed with the help of the *Perpetual Inventory method*. Towards this objective, the following set of information is used: (i)

benchmark capital stock, (ii) price of capital assets, (iii) annual gross investment, (iv) life and depreciation of capital assets. The capital stock pertaining to the year 1973/74 is taken as the benchmark stock of capital for each industry. Selection of benchmark year was based on the availability of the 'gross net ratio' at 'all India' level for various industries. Two different price series of capital stock were used for deflation purposes. For deflating the benchmark capital stock (1973/74), a weighted prices index for machinery & construction was used by averaging it backward over a period of 15 years from 1958/59 to 1973/74. For deflating the capital stock series for remaining years, an implicit price deflator is used.

The annual gross investment series at current prices for a year is derived by adding depreciation of that year to the difference of net fixed capital stock of current year and previous year. By deflating the investment series so obtained by the price of capital, the annual series on real investment was obtained for each industry under consideration. Starting from the benchmark capital stock after allowing for fixed rate of depreciation, and adding real fixed investment for successive years, the net fixed capital stock series was constructed. Capital was allowed to depreciate at the fixed rate of 5 per cent per annum, assuming the life of capital stock of 20 years, as assumed in numerous similar studies including Banga & Goldar (2004).

The series on labor inputs indicates the total persons engaged in the sector, as reported in ASI. In order to make it comparable with other series on inputs, total emoluments, representing the expenses on account of total person engaged, was deflated with a price of series of labor with 1993/94=100. Price of labor was obtained by dividing the total emoluments by the total persons engaged. Energy is represented by the series of fuel consumed as available in ASI. Owing to the fact that energy may include varying amounts of coal, petroleum products and electricity, depending upon the nature of an industry, the series on energy was deflated with the weighted price index. The material represents the series on materials consumed by industry. To arrive at its consumption at constant prices, it was deflated by a weighted price deflator.

The series on services is not directly available from ASI. Therefore, following from Banga and Goldar (2004), an indirect procedure has been applied to obtain the same. This is done by subtracting the expenses on materials and energy from the total inputs. An approximated series on services so obtained contains the following major items as per the definition provided in *ASI*: (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. For obtaining the expenses on services at constant prices, a weighted price deflator is used. The input-output table provides information on the purchases of services (transport, banking, insurance, etc.) by the manufacturing industries. Since the price deflators for services are not available, implicit price deflators for major items of services were constructed using the service sector GDP series at current and constant prices as given in NAS and corresponding weights are derived from the input-output matrix.

The data for manufacturing sectors have been drawn from the *Annual Survey of Industries* (*ASI*), published by the Central Statistical Organization (CSO), Government of India. The EPW database has been utilized to obtain data for period 1981/82 – 2003/04, whereas the same for remaining years are collected directly from the CSO, ensuring the two series matched. The WPI series on various commodities, used for converting the series from current prices to constant prices, are compiled from the Ministry of Statistics and Program Implementation, Government of India. The CSO's 'Input-Output' matrix for the year 1993/94 is used to construct weighted price indices each on materials, energy and services.[8] The values of gross net ratio (GNR) are calculated from the *Reserve Bank of India Bulletin* (1976). These values are applied to obtain series on gross value of capital stock for 1973/74 for each two digit manufacturing industry. Implicit price deflator, used to deflate the series on capital stock at current prices, is constructed by taking data from the National Accounts Statistics (NAS).

B. Structure of costs and its trends

Inputs proportions in the manufacturing process have been changing over time (Table 1). At aggregate level of manufacturing during the study period, material input occupies the largest proportion in total input costs (62.9 per cent), followed by capital (14.5 per cent), services (9.7 per cent), energy (6.4 per cent) and labor (6.5 per cent). Capital and services have witnessed increasing trend in shares whereas labour and energy saw their shares declining over the study period. Material's share has virtually remained constant over the years. Capital has seen its share increasing at the rate of 0.9 per cent per annum with wide fluctuations in growth rate across sub-periods. Services' share has moved up from 8.0% in period I to 10.7% in period II at the average annual rate of 3.1 per cent. Relatively large and varying share of services justifies inclusion of services as an additional input in the study.

The share of labor has exhibited the maximum annual decline (-3.2%). Rapid decline in share of labor is a matter of concern given the huge employment manufacturing sector is desired to create. Issues pertaining to employment needs to be addressed at policy level if the trend in share of labor is to be reversed. Many studies including that by Virmani and Hashim (2009) have derived results pointing to businesses switching to capital intensive technology, which is attributed to rigidity in labor laws. Reflecting movement towards energy efficient technology, the share of energy has witnessed a decline at the rate of 0.9 per cent per annum. It is noteworthy that much of the improvement has come about in the last sub-period of period II.

[8] *The input-output matrix provides sector specific information on the purchases of inputs from other sectors of the economy, serving a useful purpose of constructing weights.*

Table 1: Trend in Shares of factors in aggregate manufacturing (%)

Periods	Capital	labor	Energy	Materials	Services
Period I					
1981/82-	**13.0**	**8.3**	**6.8**	**63.9**	**8.0**
1990/91	**(1.8)**	**(-2.9)**	**(0.4)**	**(0.5)**	**(-3.6)**
Period II					
1991/92-	**15.3**	**5.5**	**6.2**	**62.3**	**10.7**
2007/08	**(-0.3)**	**(-3.4)**	**(-1.9)**	**(0.1)**	**(3.1)**
Sub-prd. 1					
1991/92-	15.8	6.4	6.7	62.5	8.6
1997/98	(2.0)	(-2.3)	(-0.6)	(-1.1)	(5.4)
Sub-prd 2					
1998/99-	15.1	5.5	6.3	60.3	12.8
2001/02	(-6.8)	(-1.9)	(1.6)	(2.7)	(-3.9)
Sub-prd. 3					
2002/03-	14.9	4.4	5.6	63.3	11.7
2007/08	(2.7)	(-5.2)	(-6.1)	(0.8)	(-3.0)
Study Period					
1981/82-	**14.5**	**6.5**	**6.4**	**62.9**	**9.7**
2007/08	**(0.9)**	**(-3.2)**	**(-0.9)**	**(-0.1)**	**(2.1)**

Note: Figures in parenthesis indicate average annual growth rate (%) in shares.

A wide degree of variability is found in shares of factors across manufacturing sectors (Table 2). Material constitutes the highest proportion of total input costs in Coke, petroleum products & nuclear fuel (82.6%) and Food products & beverages (75.1%). It has the lowest share in non-metallic mineral products (37.4%). Majority of the sector exhibit minor change in shares of materials over the years. The most capital intensive sectors, on the basis of shares, are Non-metallic mineral products (21.7%) and Chemicals & chemical products (19.4%) whereas Food products & beverages is on the other extreme (9.1%). Labour finds its highest application in Other transport equipments (12.8%), Textile products (9.9%) and Machinery & equipments n.e.c. (9.8%) and lowest in Coke, petroleum products & nuclear fuel (1.3%) and Food products & beverages (4%). It is interesting to note that the share of labour shows declining trend in all sectors of manufacturing over the study period. Non-metallic mineral products is the most energy using sector (23.5%) whereas the Coke, petroleum products & nuclear fuel (1.7%) and Electrical machinery & apparatus n.e.c (2.4%) use the least of it. Among the sectors using highest services are 'Others' (14.7%), Machinery & equipments (13.9%) and Fabricated metal products (13.1%). Coke, petroleum products & nuclear fuel sector (2.6%) uses the minimum of services among all the sectors of manufacturing. In all case but one share of services has increased over the study period.

Table 2: Average factors shares duing1981/82 to 2007/08: Manufacturing sectors

Sectors	Capital	Labor	Energy	Materials	Services
Food products & beverages	9.1 (0.2)	4.0 (-1.6)	3.1 (0.0)	75.1 (-0.5)	8.6 (4.7)
Textile products	11.4 (0.7)	9.9 (-3.7)	8.4 (0.9)	60.2 (-0.1)	10.1 (2.6)
Coke, petroleum products, & nuclear fuel	11.8 (3.4)	1.3 (-1.8)	1.7 (-0.4)	82.6 (-0.4)	2.6 (2.1)
Chemicals & chemicals products	19.4 (0.9)	5.6 (-2.2)	9.1 (-1.8)	55.7 (0.0)	10.2 (1.5)
Rubber & plastic products	15.2 (-0.6)	5.5 (-1.6)	5.0 (1.0)	65.3 (-0.1)	9.0 (2.0)
Non-metallic mineral products	21.7 (1.1)	7.9 (-2.3)	23.5 (0.1)	37.4 (-0.6)	9.6 (1.3)
Basic metals	15.1 (1.9)	6.1 (-3.3)	12.1 (-0.6)	57.7 (0.0)	9.0 (-0.1)
Fabricated metal products	13.0 (0.2)	8.2 (-1.7)	4.1 (1.6)	61.1 (-0.4)	13.1 (2.1)
Machinery & equipments (n.e.c)	15.8 (-0.5)	9.8 (-2.2)	3.0 (-2.0)	57.5 (0.0)	13.9 (6.1)
Electrical machinery & apparatus (n.e.c)	16.3 (0.1)	8.4 (-2.8)	2.4 (0.6)	63.4 (-0.1)	9.5 (4.9)
Motor vehicles & trailers	15.8 (-1.0)	8.2 (-4.1)	2.7 (-1.7)	63.1 (-0.2)	10.2 (2.9)
Other transport equipments	12.2 (2.4)	12.8 (-6.2)	3.2 (-2.3)	62.3 (-0.6)	9.5 (1.2)
Others	15.9 (-0.2)	8.5 (-2.7)	4.1 (-1.6)	57.0 (0.0)	14.7 (2.2)

Note: Figures in parenthesis indicate average annual growth rate (%) of the variable concerned.

C. Industry composition and its trend

The manufacturing sector in India is skewed in favor of just a few large industries (Table 3). Only 55% of the two-digit ASI manufacturing industries contributed 89% of the total output during the study period. These (55%) industries have wide differences in shares ranging from 15.8% in case of Foods products & beverages to 2.6% in case of Fabricated metal products. Composition of shares has been undergoing change over the years. Industries like Motor vehicles etc (2.8%), Coke & allied sector (1.9%), Others (0.9%) and Rubber & plastic products (0.6%) have witnessed positive annual growth in shares as opposed to others including Textiles products (-2.4%), Machinery & equipments n.e.c. (-1.3%) and Food & beverages (-0.8%) exhibiting negative growth during the study period

Table 3: Trends in shares of manufacturing sectors (%)

Periods	Food products & beverages	Textile products	Coke, petroleum products, & nuclear fuel	Chemicals & chemicals products	Rubber & plastic products	Non-metallic mineral products	Basic metals	Fabricated metal products	Machinery & equipments (n.e.c)	Electrical machinery & apparatus (n.e.c)	Motor vehicles & trailers	Other transport equipments	Others
Period I 1981/82 to 1990/91	**16.4 (-0.1)**	**11.8 (-2.7)**	**9.1 (-1.6)**	**13.8 (0.1)**	**2.9 (2.3)**	**3.8 (1.4)**	**13.5 (0.3)**	**2.6 (0.1)**	**6.1 (-1.0)**	**3.9 (0.2)**	**3.5 (1.1)**	**2.8 (0.9)**	**9.7 (3.1)**
Period II 1991/92 to 2007/08	**15.3 (-1.7)**	**9.2 (-3.5)**	**9.9 (7.9)**	**15.0 (-1.4)**	**3.3 (-0.8)**	**3.6 (-1.6)**	**12.8 (0.5)**	**2.7 (0.5)**	**5.3 (-1.5)**	**3.6 (-1.0)**	**5.1 (4.1)**	**2.7 (-1.2)**	**11.6 (-0.8)**
Sub-Prd 1 1991/92-1997/98	15.9 (-1.2)	10.7 (-0.4)	6.4 (1.2)	15.4 (1.3)	3.4 (1.5)	3.9 (-3.0)	13.0 (-1.6)	2.7 (1.1)	5.7 (-1.0)	3.8 (-1.8)	4.3 (8.6)	2.9 (-0.5)	11.8 (0.0)
Sub-Prd 2 1998/99-2001/02	16.9 (-3.4)	9.5 (2.3)	8.2 (22.6)	17.3 (-1.9)	3.5 (-4.2)	3.6 (2.6)	10.8 (-3.2)	2.4 (-3.1)	5.1 (-5.5)	3.3 (-5.8)	4.6 (2.5)	2.5 (5.7)	12.3 (1.5)
Sub-Prd.3 2002/03-2007/08	13.5 (-4.9)	7.2 (-4.0)	15.2 (4.3)	13.1 (-5.4)	3.1 (-3.1)	3.2 (1.0)	14.0 (6.3)	2.8 (9.5)	4.8 (4.1)	3.4 (8.3)	6.4 (2.1)	2.6 (-2.8)	10.9 (-3.7)
Study prd. 1981/82 to 2007/08	**15.7 (-0.8)**	**10.2 (-2.4)**	**9.6 (1.9)**	**14.6 (0.1)**	**3.2 (0.6)**	**3.7 (-0.6)**	**13.1 (-0.2)**	**2.7 (0.1)**	**5.6 (-1.3)**	**3.7 (-0.7)**	**4.5 (2.8)**	**2.7 (-0.4)**	**10.9 (0.9)**

Note: (i) Figures in bracket indicate the average annual growth of the corresponding share, (ii) Industry with a share of less than 5% are classified under the category 'others'.

D. Trends in output and input growth

The output and inputs of aggregate manufacturing have grown at varying pace during the study period (Table 4). The output grew by 7.7 per cent per annum during period I and improved to 8.2% in period II. Period II growth in output shows high degree of variability across sub-periods from 7.4% in first sub period to 2.7% in second sub period and 12.9% in the third sub period. The main reason for a slump in output growth during second sub-period was the slowing domestic and global demand. Buoyant growth of domestic and global economy during the third sub-period led a healthy growth in manufacturing output too. Growth in inputs, in general, moved in the same direction as output growth. Materials showed the highest annual growth (8.2%) during the study period followed by capital (7.7%), services (7.5%) and energy (5.1%). Labour input, on the other hand, grew merely by 1.6% per annum. There have been significant differences in growth of majority of inputs between Period 1 & II. While the growth of capital and energy declined in period II that of labour and services increased heavily.

Table 4: Growth in output and inputs: Aggregate manufacturing (%)

Periods	Output	Capital	Labour	Energy	Materials	Services
Prd. I (1981/82 - 1990/91)	**7.7**	**9.1**	**0.7**	**8.0**	**8.1**	**2.7**
Prd. II (1991/92 - 2007/08)	**8.2**	**7.0**	**2.1**	**3.6**	**8.3**	**10.1**
Sub-prd. 1 (1991/92 - 1997/98)	7.4	8.7	2.3	3.8	6.3	14.7
Sub-prd. 2 (1998/99 - 2001/02)	2.7	5.0	-3.3	-3.2	4.1	0.0
Sub-prd 3 (2002/03 - 2007/08)	12.9	6.3	5.4	8.0	13.4	11.4
Study Prd. (1981/82 - 2007/08)	**8.1**	**7.7**	**1.6**	**5.1**	**8.2**	**7.5**

Note: Figures are at constant prices (1993-94 = 100)

IV. Methodology for TFPG

Output growth from larger application of inputs is not as relevant to the issue of reform effectiveness as growth from improvement in productivity of inputs. Productivity growth is also relevant for sustaining growth over the medium-long run, given its link cost competitiveness of industries.

We start by looking at partial factor productivity before moving on to total factor productivity (TFP). Partial factor productivity is calculated by dividing the total output by the quantity of an input. The main problem in using this measure of productivity is that it ignores the fact that productivity of an input also depends upon the level of other inputs used. For example, a higher dose of capital application may increase the productivity of labor even when other inputs including labor remain constant. The TFP approach overcomes this problem by taking into account the levels of all inputs used in the production of output. Partial factor productivity, nevertheless, is useful in understanding a few details not evident from the TFP analysis. In present study, therefore, both partial as well as TFP are estimated for the manufacturing industries.

The TFP growth can be calculated in number of ways. However, the two most common approaches used in case of Indian manufacturing are 'growth accounting' and 'econometric estimation'. Growth accounting measure estimates the TFP growth by subtracting the weighted input growth from the output growth. The difference so obtained includes the effects of technological progress, scale of production, learning by doing, technical efficiency etc. The productivity growth can be understood to represent the exogenous shift of a frontier production function [Srivastava (1996)]. Though the genesis of this approach can be traced back to the works of Tinbergen (1942) and Solow (1957), it was Jorgenson (1987) who showed that under certain conditions, the growth rate of TFP could be estimated as the growth rate of output minus the growth rate of total input. The growth accounting approach is based on the assumption that producers are price takers in both output as well as inputs markets, so that output prices are equal to the marginal costs of production and factors are paid their respective marginal products. The approach also assumes technology to be of constant returns to scale. When it is difficult to satisfy these assumptions,

a direct econometric estimation of production function is usually undertaken, which however, has its own limitations. The problems such as multi-colinearity, autocorrelation and the need for large sample associated with the econometric estimation procedure may often pose serious challenge to the correct estimate of the parameters of production function [Trivedi *et al.* (2000)]. In order to avoid these problems, the present study makes use of growth accounting approach for estimation of productivity growth.

There are various approaches within the growth accounting technique of estimating productivity growth. The present study is based on Translog index (instead of Kendrick Index or Solow Index) which allows for variability in elasticity of substitution between factors of production and does not assume that technological progress is Hicks-neutral. Most of the recent studies on the measurement of productivity in the Indian industries have undertaken discrete approximation of the Translog Production Function in the form of Translog Index.

For a five inputs case, the Translog Index can be defined as follows:

$$\Delta \ln TFP_t = \Delta \ln Y_t - \left[\frac{(SK_t + SK_{t-1})}{2} \times \Delta \ln K_t\right] - \left[\frac{(SL_t + SL_{t-1})}{2} \times \Delta \ln L_t\right] - \left[\frac{(SE_t + SE_{t-1})}{2} \times \Delta \ln E_t\right] -$$

$$- \left[\frac{(SM_t + SM_{t-1})}{2} \times \Delta \ln M_t\right] - \left[\frac{(SS_t + SS_{t-1})}{2} \times \Delta \ln S_t\right]$$

In the above equation, Y = output, K = capital, L = labor, E = energy, M = materials, and S = services. SK, SL, SE, SM and SS are income shares of capital, labor, energy, materials, and services, respectively. All the income shares sum up to unity.

V. Empirical Findings

A. Partial factor productivity growth

The results on partial factor productivity (PFP) show varied patterns across sub-periods as well as sectors (Table 5, Table 6 & Chart 1). The maximum annual growth in productivity during the study period occurred in case of labour (6.6%) and energy (3.3%). While productivity of capital (0.1%) and materials (0.1%) increased only marginally, there has been a significant decline in productivity of services (-1.7%). Except labor, all the inputs show wide difference in productivity in period I and II. While capital, energy and materials saw their productivity increasing heavily in period II from period I, services recorded a substantial decline during the period. Much of the improvement in productivity of capital came form the third sub-period, led by improvement in capacity utilization. Productivity of capital in the first sub-period was negative before registering some improvement in the

second sub-period. Energy has shown improvement in productivity throughout the period II. Even though the productivity of materials improved marginally in period II, it has declined heavily in the last two sub periods. Considering that materials constitute dominant portion of total cost, negative growth in productivity of materials in latest two sub-periods is not a good sign as this adversely affects the overall productivity and cost competitiveness of the manufacturing industries. Services, after recording heavy contraction in productivity in first sub-period, have done well in the last two sub-periods of period II.

Labor and energy productivity in the manufacturing sector, follow an S curve pattern (table 5). Labor productivity growth remains firm in the first two sub-periods around the 6.1% per annum level of the 1980s and then accelerates to 7.5% per annum in the third sub-period. Energy productivity growth in contrast accelerates from negative during the 1980s to over 5% during the first two sub-periods and then moderates in the third. Capital and materials show a hybrid S-J pattern of partial factor productivity growth, with both accelerating in the first sub-period, decelerating in the second and accelerating above the 1980s rate in the third sub-period. The Productivity of Service inputs into manufacturing shows a J curve pattern with productivity growth decelerating from 4.4% per annum during the 1980s to -8.3% per annum in the first sub-period of the 1990s reform (table 5). Thereafter it recovers in the second sub-period and moderates in the third, but remains below the growth rate of the 1980s.

Table 5: Growth in partial productivity of factors: Aggregate manufacturing (%)

	Capital (Y/K)	Labor (Y/L)	Energy (Y/E)	Materials (Y/M)	Services (Y/S)
Period I (1981/82 - 1990/91)	**-1.1**	**7.3**	**-0.2**	**-0.8**	**4.9**
Period II 1991/92 - 2007/08	**2.0**	**7.3**	**5.5**	**0.3**	**-3.0**
Sub-prd. 1 (1991/92 - 1997/98)	-0.4	6.1	4.5	1.5	-4.7
Sub-prd. 2 (1998/99 - 2001/02)	0.5	6.7	6.3	-2.7	3.0
Sub-prd. 3 (2002/03 - 2007/08)	6.2	6.7	6.9	-1.3	2.5
Study Period (1981/82 - 2007/08)	**0.1**	**6.6**	**3.3**	**0.1**	**-1.7**

Source: Authors' own calculation based on ASI data.

The S curve pattern of Energy and Labor productivity growth is probably linked to the use of new types of capital goods and embodied technology that is more energy efficient and capital intensive. The rigidity in labor laws adds to the incentive for using capital intensive technology and restricting the hiring of additional workers [Virmani (2004), (2005a); Virmani & Hashim (2009)]. The difference in the S pattern suggests that the effect on energy is immediate, while 'learning by doing' by labor delays the beneficial impact on labor productivity somewhat. That energy has witnessed continuous and healthy improvement in productivity is an indication of energy saving technology in the 1990s.

It is also interesting that capital productivity growth, though it followed a hybrid S-J pattern remained negative through the first and second sub-periods before accelerating sharply in the third sub-period to 6.6 per cent per annum. This may have been partly due to replacement of obsolescent capital stock by machinery and equipment of much higher minimum efficient scale, which necessitated building ahead of demand. This would have meant that capacity utilization of new equipment was not initially very high and gradually increased. Productivity growth in materials accelerated (+2.5% vs. +2.2%) in the first sub period and then decelerated (-3.2% vs. -2.2%) in the second sub-period by a little more in percent points than did capital productivity. However, it remained negative in the third sub-period, indicating that there is still scope for more efficient use of material inputs in Indian manufacturing.

Services have been the only inputs showing a J-curve pattern and registering a decline in annual productivity during period II. Average annual productivity of services declined heavily during first sub-period, when its application in production process grew by nearly 17 per cent per annum. Not surprisingly, Banga & Goldar (2004) found a decline in overall productivity growth of Indian manufacturing for the post reforms period (1990/91 to 1999/2000) after they incorporated services as additional input in the model. With stagnation in the level of services as an input in the second sub-period, the productivity of services grew by over 2.5 per cent per annum. In third sub-period, the growth rate of services productivity decelerated when its application in manufacturing process grew by over 11 per cent per annum. Services productivity growth has turned positive from late 1990s. Services are therefore, no longer a drag on overall productivity of manufacturing, as was found during much of the 1990s. With development of economically and technically efficient infrastructure facilities, such as banking, trade, transport, hotels etc, the productivity of services may move up further and would even strongly contribute to the overall growth in productivity.

The major manufacturing sub-sectors, in general, show similar trends in partial factor productivity growth as seen at the aggregate level of manufacturing sector. Partial Factor productivity of both Energy and Labor show a fairly strong acceleration as a consequence of the 1990s reform, though the precise pattern varies across the sub-sectors (Table 6). One exception to this is Labor productivity growth in the Chemicals and Chemical products sub-sector which has decelerated relative to that in the 1980s. In the case of capital productivity growth four sub-sectors follow the basic J curve pattern seen for the manufacturing sector as a whole, while Textiles products follow a S curve pattern and 'Basic metals' and 'Machinery & equipment' a hybrid S-J one.

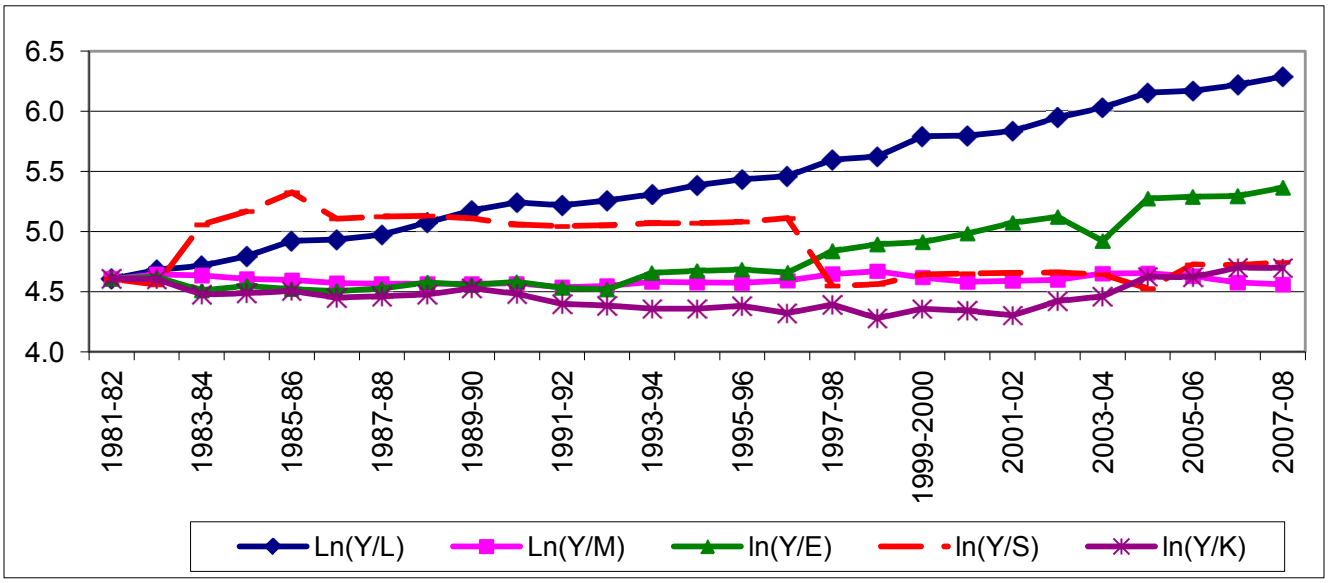
Both materials and services productivity show the same hybrid S-J pattern across sub-sectors as in the manufacturing sector as a whole, with one exception. Material productivity growth follows an S curve pattern in the 'Coke, Petroleum products and Nuclear Fuel sub-sector.

Table 6: Growth in partial factor productivity across manufacturing sub-sectors

	SS 1	SS 2	SS 3	SS 5	SS 6	SS 7	SS 8	SS 9	SS 10	SS 11	SS 12	SS 13	SS 14
						PFP of Capital							
1981/82 to 1990/91	**-1.4**	**-2.4**	**-2.4**	**1.4**	**-1.6**	**-4.6**	**-0.9**	**-4.3**	**-1.5**	**-0.9**	**-0.4**	**4.8**	**1.7**
1991/92 to 2007/08	**-0.7**	**1.4**	**-1.2**	**0.9**	**3.1**	**0.9**	**2.9**	**3.7**	**3.8**	**4.8**	**3.6**	**5.2**	**1.3**
1991/92 to 1997/98	-3.3	-1.8	-0.8	-2.1	-2.9	-3.6	1.3	0.2	4.1	2.7	6.1	6.1	1.8
1998/99 to 2001/02	-4.4	1.4	3.9	-4.8	0.6	4.9	7.9	0.5	-1.5	-4.6	2.0	4.0	0.9
2002/03 to 2007/08	1.7	4.6	10.6	4.1	7.7	4.7	4.2	7.8	10.8	17.7	6.8	6.0	5.0
1981/82 to 2007/08	**-1.6**	**-0.5**	**-3.7**	**0.5**	**1.1**	**-1.2**	**0.4**	**0.0**	**1.4**	**2.0**	**1.5**	**5.0**	**0.0**
						PFP of Labor							
1981/82 to 1990/91	**9.3**	**7.4**	**5.7**	**7.8**	**6.8**	**8.7**	**6.1**	**2.9**	**6.7**	**5.8**	**7.4**	**8.9**	**6.6**
1991/92 to 2007/08	**4.9**	**7.1**	**9.6**	**5.1**	**6.6**	**5.1**	**7.4**	**7.6**	**8.9**	**10.0**	**9.9**	**14.7**	**6.1**
1991/92 to 1997/98	3.4	8.2	5.4	3.9	5.6	5.9	6.1	7.9	9.9	10.0	13.9	8.2	3.9
1998/99 to 2001/02	0.8	6.7	15.3	0.5	4.9	4.0	7.4	2.5	18.1	2.7	10.0	28.6	3.5
2002/03 to 2007/08	5.8	6.9	7.8	5.7	6.0	6.4	4.2	9.5	10.6	13.5	6.7	7.4	4.9
1981/82 to 2007/08	**5.2**	**7.2**	**4.7**	**5.7**	**6.7**	**6.2**	**6.9**	**5.5**	**7.4**	**7.8**	**8.6**	**11.1**	**5.8**
						PFP of Energy							
1981/82 to 1990/91	**-1.0**	**-0.9**	**-8.0**	**2.8**	**0.8**	**-2.7**	**-0.2**	**-4.6**	**3.4**	**0.1**	**2.7**	**2.1**	**0.4**
1991/92 to 2007/08	**3.2**	**5.5**	**5.0**	**6.2**	**5.1**	**5.2**	**2.8**	**6.0**	**6.7**	**7.3**	**8.4**	**8.8**	**6.0**
1991/92 to 1997/98	2.7	3.9	-0.1	4.8	3.2	1.5	4.5	4.3	6.9	5.0	7.7	7.1	4.0
1998/99 to 2001/02	5.6	7.6	52.7	0.1	7.5	10.8	4.5	3.0	6.2	6.2	11.8	11.1	6.6
2002/03 to 2007/08	3.2	9.2	-12.9	8.4	7.5	3.4	3.6	12.5	15.7	8.6	10.9	10.3	11.3
1981/82 to 2007/08	**1.5**	**3.1**	**0.2**	**5.0**	**4.1**	**2.3**	**2.2**	**1.1**	**5.7**	**4.1**	**5.3**	**6.0**	**3.6**
						PFP of Materials							
1981/82 to 1990/91	**0.7**	**-0.2**	**-5.5**	**-0.3**	**-0.9**	**0.7**	**-1.1**	**-1.4**	**-0.9**	**0.5**	**-1.0**	**-1.4**	**1.9**
1991/92 to 2007/08	**1.2**	**0.5**	**-0.5**	**-0.8**	**-1.4**	**-0.5**	**-0.1**	**1.1**	**0.5**	**2.7**	**1.3**	**0.7**	**0.5**
1991/92 to 1997/98	1.0	1.1	-1.4	-0.2	-1.1	1.3	4.4	2.7	4.4	6.3	0.7	2.4	0.4
1998/99 to 2001/02	-1.5	-0.6	-3.2	-5.4	-2.0	-1.2	-3.8	-0.3	-1.3	-3.5	-2.1	-1.9	2.0
2002/03 to 2007/08	-0.3	-0.2	-0.3	-0.5	-4.0	-2.7	-5.2	-3.1	-2.7	-0.6	0.9	0.1	0.1
1981/82 to 2007/08	**0.8**	**0.1**	**-2.4**	**-0.7**	**-0.5**	**0.1**	**0.5**	**0.5**	**0.3**	**2.2**	**0.6**	**0.2**	**0.1**
						PFP of Services							
1981/82 to 1990/91	**9.7**	**7.6**	**2.7**	**6.3**	**3.8**	**3.4**	**5.6**	**2.5**	**0.8**	**-3.1**	**3.1**	**2.5**	**1.6**
1991/92 to 2007/08	**-9.2**	**-2.0**	**-3.3**	**-2.5**	**0.8**	**-0.8**	**-2.8**	**-1.9**	**-0.5**	**0.0**	**-2.2**	**-0.5**	**3.1**
1991/92 to 1997/98	-9.9	-5.1	-3.7	-5.7	-1.5	-4.2	-1.4	-5.1	-2.5	-5.1	0.2	-0.4	4.4
1998/99 to 2001/02	0.4	1.9	-3.6	6.7	21.5	6.8	2.0	4.7	2.1	11.7	-5.8	6.3	4.0
2002/03 to 2007/08	0.9	3.1	-5.9	1.9	6.5	0.5	-3.1	5.1	1.8	3.2	8.6	2.7	2.0
1981/82 to 2007/08	**-4.7**	**-0.2**	**-3.9**	**-0.9**	**0.8**	**-0.7**	**-0.1**	**-1.5**	**-2.2**	**-2.6**	**-1.8**	**0.1**	**2.4**

Abbreviations: SS 1 = Food products & beverages; SS 2 = Textile products; SS 3 = Coke, petroleum products, & nuclear fuel; SS 4 = Chemicals & chemicals products; SS 5 = Rubber & plastic products; SS 7 = Non-metallic mineral products; SS 8 = Basic metals; SS 9 = Fabricated metal products ; SS 10 = Machinery & equipments (n.e.c.) ; SS 11 = Electrical machinery & apparatus (n.e.c); SS 12 = Motor vehicles & trailers ; SS 13 = Other transport equipment; SS 14 = Others.

Chart 1: Trends in partial factor productivity of aggregate manufacturing [Logarithmic Indexes 1981/82 = Ln (100)]



SouSource: Based on Authors' own estimates using ASI data

B. Total factor productivity growth (TFPG)

The last column (14) of Table 7 shows a clear J-curve pattern of total factor productivity growth for Manufacturing as predicted by the J- curve hypothesis (see appendix). TFP grew at 0.6 per cent per annum in the 1980s, slowed to 0.25 per cent per annum in the first sub-period of the 1990s reform and declined (-0.1 per cent) during the second sub-period. Thereafter total factor productivity growth accelerated sharply to 1.4 per cent per annum in the third sub-period more than twice the TFPG during the 1980s. Thus TFP Growth in organized/registered manufacturing follows the J-curve pattern predicted by Virmani (2005a). This in turn was reflected in output growth in manufacturing and in investment and growth in non-manufacturing.

The BOP crisis that started in 1990 and impacted the economy severely in 1991 had its greatest impact on the manufacturing sector. The manufacturing sector was also the one most directly affected by the trade and foreign exchange reforms of the 1990s [Virmani (2006b)].[9] Thus the J-curve of productivity and Growth [see Appendix] is most relevant for the path of TFPG in this sector. TFPG growth was slow in the first sub-period mainly because of the combined effects of the BOP shock and the J-curve effect arising from the

[9] Note however, that reduction of import protection for tradable goods like manufacturing and minerals, will also affect relative prices of non-tradable services.

dramatic import liberalization (removal of QRs on capital goods and intermediates and tariff reduction) and exchange rate reforms of the early 1990s (from fixed rate to managed float). With completion of the liberalization in the late nineties-early 2000s, with removal of QRs on consumer goods and further reduction in import duties, certain types of capital goods were rendered obsolescent, resulting in further contraction in capacity utilization and hence TFP during the second sub-period. The slowdown of economy during late nineties to early 2000s accentuated the fall. As the dissemination of new technologies and products progressed from early adopters to others and capacity was also adjusted appropriately, TFPG accelerated sharply during the third sub-period.

The J curve pattern of productivity (and output) growth was likely accentuated by the rigidity of labor laws in the country, which restricts the benefits of immediate increase in productivity from reallocation of resources across sectors. It is well known that trade liberalization leads to static and dynamic gains. The static allocation efficiency gains arise as a result of resource reallocation from inefficient to efficient industries, leading to aggregate productivity gains. Labor market rigidities make it extremely difficult to reallocate resource from one sector (or firm) to another sector (or firm). Thus, this immediate and one time gain in productivity is weak or absent in the organized manufacturing due to labor laws which prevent inter-sectoral (and inter-firm) resource reallocation. The delayed response to reforms could be linked to the dynamic productivity gains that are available in the longer term and are persistent. Dynamic gains arise as a result of learning by doing, exploitation of scale economies, R&D, positive spillover effects from participation in foreign trade and from the operation of multinationals in the domestic industry. All these lead to long-run productivity growth while short-term (immediate) productivity growth is absent due to inability of the industries to exploit static allocation efficiency gains.

Manufacturing Sub-Sectors

Productivity growth across manufacturing sub-sectors, substantially conforms to the trend of productivity growth found for total manufacturing. Out of the twelve major sub-sectors of manufacturing TFPG, two followed the S curve pattern, five followed the J curve pattern and the remaining five followed a hybrid S-J pattern (table 7, last row). The entire J curve is complete in two, "Textile Products' (column 3) and Chemicals and Chemical Product(s) (column 5), with the trough occurring in the first sub-period. In 'Food Products and Beverages' (column 2) the recovery in TFPG has been slow and is still incomplete, even though the trough occurred in the first sub-period. The J curve is also complete in 'Other Transport equipment,' even though the trough stretches over two sub-periods (the first and second). In the fifth, Rubber and Plastic Products, there appears to be a J curve pattern in the first two sub-periods followed by a productivity collapse. The two sub-sectors showing an S curve pattern are, 'Coke, Petroleum Products and Nuclear Fuel' and 'Machinery and Equipment', though the latter is also followed by a productivity slowdown. Both slowdowns are linked to the time pattern of reforms and are discussed below. The five sub-sectors characterized by an S-J pattern are, 'Motor vehicles (column 10),' 'Electrical Machinery'

(column 11), 'Non-metallic mineral products,' 'Basic Metals,' and 'Fabricated Metal Products.'

If we break up the 'Others' into the 10 minor sub-sectors constituting it, one- Medical Precision and Optical Instruments- follows the S curve pattern, four follow the J curve pattern and 4 follow the S-J hybrid pattern (table 8). , The sub-sectors following the J curve pattern are, Paper and products namely Wearing Apparel and Fur and Wood products and possibly Television, Radio and Communication equipment, though the last three had not recovered their eighties TFPG growth levels by the 3rd sub-period. Though 'Television, Radio, and communication' appears to follow a J curve pattern, the recovery is so weak by the 3rd sub-period that is difficult to be sure that it not a failed sub-sector. The hybrid S-J pattern is seen in Printing & Publishing, 'Furniture & other products,' Leather & related products,' and 'Tobacco & related products.' Finally one sub-sector 'Accounting, Office & computing machinery is clearly on a down trend to failure.

In the major and minor manufacturing sub-sectors that do not follow the J curve pattern, certain special features of the Indian pre-reform situation such as the mixed public-private production oligopoly, and/or the pattern of import liberalization over the 1990s play a role in creating an S-curve or hybrid S-J curve.

At the end of the 1980s, textiles sector was one of the highest shareholders in manufactured exports. Most of these exports were however of Cotton textiles consumer products. The rest of textiles industry particularly that based on man-made fibers and synthetic material was highly protected and inefficient. The position was similar in woolen, silk and other textiles and to some extent in cotton yarn and other intermediates. Thus the textiles sector as a whole shows a strong J curve effect on TFPG. (1.2%; 0.49% 1.2%, 1.8%). Productivity, however never declined because of the global competitiveness of the exportable part of this sub-sector. The chemicals and chemical sector also shows a clear J curve pattern (1.7%, -1.25%, -0.3%, 1.7%). This sub-sector is characterized by a diversity of products and producers (including many small scale ones) so that the diffusion of technology may have been slower, so that overall productivity growth had just returned to the rate of the 1980s, in the last sub-period.[10] TFPG in 'Other Transport equipment' declined from a relatively high 2% per annum during the eighties to an average of about 1.7% per annum during the first and second sub-periods, then recovered sharply to 2.75 per annum in the last sub-period (Table 7). TFPG growth in Food products and Beverages also follows the J curve (2.0%, -0.56%, -0.24%, 0.95%) but has not returned to the 1980s rate. Part of the reason is that Indian tastes in food and beverages differ quite substantially from those of Western ones. The multiplicity of small scale labor intensive producers of Indian foods and beverages may be highly competitive in these products as there is no frontier capital intensive technology for these specialized products. Further given the limits of market size for Western style products, they are unable to exploit the economies of scope and scale using the standard frontier technology.

[10] India generally had and retains an advantage in semi-skilled labor intensive chemicals and not in capital intensive and high tech ones. These would be affected to different degrees and have different speeds of recovery.

One of the highest technological gaps (from the global frontier) was in the Automobile sector, particularly in personal cars. The technology in Transport vehicles like trucks was what may be termed "appropriate technology," not quite at the global frontier, but appropriate to India' road conditions and haulage practices! There is therefore a sharp J-curve effect relative to the 1981-2 to 1997-98 in the Motor vehicles & allied sub-sector with a fall in Total factor productivity in the second sub-period that declined at (-) 2.3% per annum.[11] Thereafter it accelerated to 4% per annum, about five time that of the earlier period.

[11] This was preceded by an initial acceleration in TFPG in the first sub-period as marginal improvements in non-car production led to higher productivity growth.

Table 7: TFP Growth in Indian Manufacturing Sub-Sectors (%)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Period	**FOOD Products & Beverages**	**Textile Products**	**Coke, Petroleum Products & Nuclear Fuel**	**Chemicals & Chemical Products**	**RUBBER & PLASTIC Products**	**NON-Metallic Mineral Products**	**BASIC METALS**	**Machinery & Equipment n.e.c.**	**Motor Vehicles, Trailers & Semi-Trailers**	**Electrical Machinery & Apparatus, n.e.c.**	**Other Transport Equipment**	**Fabricated METAL Products**	**All Manufa-ctures**
Period I 1981/82 - 1990/91	1.98	1.17	-4.70	1.72	0.52	0.03	0.34	0.35	0.57	1.90	2.05	-1.26	0.61
Period **II** 1991/92- 2007/08	0.05	1.12	-0.91	0.01	0.31	0.93	0.73	1.23	1.33	2.27	2.07	1.48	0.58
Sub-period **1** 1991/92- 1997/98	-0.56	0.49	-3.99	-1.25	0.16	0.29	2.99	1.77	1.09	3.10	1.68	1.60	0.25
Sub-period **2** 1998/99 - 2001/02	-0.24	1.20	-0.47	-0.33	0.92	1.69	-1.04	1.00	-2.27	-0.05	1.72	1.71	-0.09
Sub-period **3** 2002/03 - 2007/08	0.95	1.78	2.39	1.71	0.07	1.18	-0.74	0.75	4.02	2.84	2.75	1.20	1.41
All/Total 1981/82 - 2007/08	**0.72**	**1.13**	**-2.22**	**0.60**	**0.38**	**0.62**	**0.59**	**0.93**	**1.07**	**2.14**	**2.06**	**0.53**	**0.59**
Curve Pattern	J	J	S	J	J-	S=>J	S=>J	S-	S=>J	S=>J	J	S=>J	J

Table 8: TFP Growth in "Others" Manufacturing Industries (%)

1	2	3	4	5	6	7	8	9	10	11	12
PERIOD	**Tobacco & related Products**	**Wearing Apparel, Fur Dressing & Dyeing**	**LEATHER & Related Products**	**WOOD & WOOD Products**	**PAPER & PAPER Products**	**Publishing, Printing & Related Activities**	**Accounting, Office & Computing Machinery**	**Television Radio & Communication Equipment**	**Medical, Precision & Optical Instrument**	**Furniture Manufacture n.e.c**	**Others Total**
Period I 1981/82 - 1990/91	-0.59	2.08	-0.33	3.34	-0.29	-3.02	6.55	3.85	-1.04	-0.52	-0.37
Period **II** 1991/92- 2007/08	-0.54	0.55	0.9	-3.46	0.2	-0.86	0.92	0.15	0.22	1.69	0.49
Sub-period 1 1991/92 - 1997-98	0.54	-0.78	1.31	-10.03	-1.30	-2.12	3.89	0.84	-0.86	2.80	-0.05
Sub-period 2 1998/99 - 2001/02	-1.55	1.11	-0.08	1.13	0.32	-4.62	-0.48	-1.58	-0.81	-0.68	-0.24
Sub-period 3 2002/03 - 2007/08	-1.14	1.71	1.08	1.13	1.86	3.12	-1.62	0.48	2.17	1.98	1.6
All/Total 1981/82 - 2007/08	**-0.56**	**1.08**	**0.48**	**-1.11**	**0.03**	**-1.61**	**2.87**	**1.43**	**-0.22**	**0.93**	**0.19**
Curve Pattern:	**S=>J**	**J**	**S=>J**	**J**	**J**	**S=>J**	**-**	**J-**	**S**	**S=>J**	**S=>J**

Conventional Productivity Effects

Three major manufacturing sub-sectors were affected by the large share of Public sector in production which overlay and modified the J curve effects. 'Electrical Machinery' shows a spurt in productivity from 1.9% per annum in the eighties to 3.1% per annum in the first sub-period followed by J curve trough of -0.05% and sharp recovery to 2.8% per annum in the last sub-period. The heavy electrical machinery sub-sector had a major presence of public sector production prior to 1990 reforms. The lifting of controls on investment by private sector and the freedom of access to new technology, probably led to a rapid expansion of private production and an increase in competitiveness. This raised the overall TFPG rate and staved off for some time the effects of major liberalization.[12] Basic Metals show a similar pattern for the same reasons but with a very slow recovery (0.34%, 3.0%, -1.0%, -0.74). The Public sector was prominent in steel production, Aluminum and other non-ferrous metals. The productivity spurt occurred in industries such as Steel, Aluminium and Manganese where India has high quality ores and was and remains relatively competitive. However, this was not true of most other nonferrous metals such as zinc and tin, which very based largely on low quality domestic ores, and which probably show little or no recovery.[13] The third sub-sector in which the same Public-Private dynamics were important is 'Coke, Petroleum and Nuclear Fuel'. In addition the Petroleum refinery industry also benefited from continued high protection, which allowed the private sector to take risks in bringing in the frontier technologies and world beating technologies. As a result the TFPG in this sub sector has improved progressively from -4.7% per annum in the eighties to 2.4% in the last sub-period (column 4, table 7). Exports of petroleum products have also grown rapidly in the last 5 years or so.

Effect of Delayed Liberalization

Two major manufacturing sub-sectors were significantly affected by the delayed liberalization of consumer goods imports resulting in a hybrid S-J and a J- (weak recovery) pattern respectively. 'Non metallic mineral products' in which, TFPG accelerated in the first two sub-periods (0.03%, 0.3%, 1.7%) and then decelerated to 1.2% per annum in the third sub-period that followed the removal of quantitative restrictions on consumer imports. Several industries in this sub-sector produce highly labor intensive products (e.g. bricks) in the Small scale sector (SSI), in which the technology gap with capital intensive production techniques may not have mattered. 'Rubber and Plastic Products' which consist of wide range intermediate and consumer products, initially saw the entire J curve effect with a trough in the first sub-period and a TFPG in the second sub-period exceeding the eighties (0.5%, 0.16%, 0.92%). However, TFPG declined to 0.07% per annum in the third sub-period, after the removal of QRs on consumer goods. Four minor sub-sectors, Fabricated Metal Products' (1.3%; 1.6%, 1.7%, 1.2%), 'Tobacco and products'(-06%; 0.5%, -1.6%, 1.1%), 'Leather and related

[12] The Public sector would continue to operate even with reduced profits or losses.
[13] Copper production is somewhere in between.

products' (-0.3%; 1.3%, -0.1%, 1.1%)' and 'Furniture' (-0.5%; 2.8%, -0.7%, 2.0%) also seem to have been affected by the delayed removal of QRs on consumer products. All four consequently follow a hybrid S-J pattern with immediate productivity gains followed by a set back later. Except for the first, in which TFPG remained relatively high at the trough, in the three others the recovery of TFPG had already started in the third sub-period.

The machinery & equipments sub-sector follows the S curve pattern, with a sharp rise in TFPG growth in the first sub-period and then a gradual decline in the next two sub-periods (0.35%; 1.8%, 1%, 0.8%). The initial jump in productivity is due to the increased access to technology and effective use of profits arising from continued protection. Subsequently TFPG has declined with a decline in effective protection to neutral levels. The minor sub-sector 'Medical, precision and Optical equipment' also follows the S curve pattern, with productivity rising continuously (-1.0; -0.86, -0.81, 2.2%). The non-metallic mineral products In contrast another capital goods sector, Accounting office and computing machinery follows an opposite pattern with a continuous decline in TFPG, suggestive of an un-competitive sub-sector that is unlikely to survive external competition.

C. J-curve of output growth

Total manufacturing sector output also followed a Hybrid S-J pattern of growth, accelerating from 7.7 per cent per annum in period I (1980s) to 8.2 per cent per annum in the first sub-period of period II (1990s). It then decelerated to 2.7 per cent in second sub period before surging to 12.9 per cent in third sub-period (table 9). Productivity undoubtedly had a great role in this with its share in output growth moving from 10.7 per cent in first sub period to -3.5 per cent in second sub period to nearly 11 per cent in third sub period. Other sources of output growth, namely capital, labor, energy, materials and services, too played a crucial role in making output growth behave in a J-curve fashion during the post economic reform period.

Capital, which contributed a significant 1.4 per cent to the total output growth in the first sub-period on the back of buoyant investment activities, saw its contribution shrinking to nearly half (0.8%) in second sub period. It then recovered its contribution to 0.9 per cent during third sub period even as its share in total output growth fell, indicating improvement in capacity utilization. Contributions from labor energy, materials and services show similar pattern. Owing to dominance in production process and closely linked to output changes, materials accounting for more than 60 per cent of the output growth over the study have been having the largest impact to the pattern of output growth, followed by services (12.7%) and capital (12.3%). Labor and Energy together have contributed less than 6 per cent of the output growth.

Table 9: Sources of output growth in aggregate manufacturing (%)

Period	Growth in Output	Sources of Output Growth					
		K	L	E	M	S	TFPG
Prd I 1981/82 - 1990/91	**7.74**	**1.19 (15.3)**	**0.05 (0.6)**	**0.54 (6.9)**	**5.21 (67.4)**	**0.14 (1.8)**	**0.61 (7.9)**
Prd II 1991/92- 2007/08	**8.23**	**1.08 (13.1)**	**0.10 (1.3)**	**0.22 (2.6)**	**5.18 (63.0)**	**1.07 (13.0)**	**0.58 (7.0)**
Sub-prd 1 1991/92 - 1997/98	**7.41**	1.37 (18.5)	0.15 (2.1)	0.25 (3.3)	3.98 (53.6)	1.42 (19.1)	0.25 (3.4)
Sub-prd 2 1998/99 - 2001/02	**2.67**	0.77 (28.9)	-0.18 (-6.8)	-0.21 (-7.7)	2.38 (88.8)	0.01 (0.3)	-0.09 (-3.5)
Sub-prd 3 2002/03 - 2007/08	**12.88**	0.94 (7.3)	0.24 (1.9)	0.46 (3.6)	8.46 (65.7)	1.36 (10.6)	1.41 (11.0)
Study prd. 1981/82 - 2007/08	**8.06**	**1.12 (13.8)**	**0.08 (1.1)**	**0.33 (4.1)**	**5.19 (64.4)**	**0.75 (9.3)**	**0.59 (7.3)**

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

Out of the twelve major sub-sectors of manufacturing considered above, output growth in one showed an S curve pattern, three showed a J curve pattern and eight showed a hybrid S-J pattern. Out of these, in seven sub-sectors the pattern was the same as for TFPG growth. However, for five sub-sectors it was different. In three of these sub-sectors ('rubber and plastic products', 'non-metallic mineral products', and 'Other transport equipment', fabricated metal p) changes in output growth and TFPG growth were inversely related across periods-sub-periods. In the 'Textile sub-sector, ouput growth accelerated in the first sub period, while TFPG growth decelerated, while in the Machinery and equipment sector there was an acceleration of both output and TFPG in the first sub-period. In neither case was the correlation maintained with the same sign in subsequent sub-periods!

VI. Conclusion

Economic policy reforms, such as those carried out in India in the 1980s and then in the 1990s are expected to result in an acceleration in rate of the growth of the economy. Underlying this growth acceleration are short term gains in Static Efficiency through re-allocation of factors to different uses and firms and dynamic efficiency gains. At the sector level, such as manufacturing, we would expect a positive effect on growth as well as total factor productivity, which are expected to broadly follow an **S-shape** pattern in moving from the lower steady state to a higher steady state level. At more disaggregated level of manufacturing sub-sectors we would expect a majority of sub-sectors to follow an S-curve pattern, but to also find some sub-sectors that will in fact decline because they are fundamentally non-competitive (comparative disadvantage). The puzzle of India's reforms was that such a pattern was indeed found consequent to the 1980s reforms, but no such pattern (aggregate) or perhaps even an inverse pattern

(sector/industry) was found after the 1990s reforms. The latter appeared to lend support to the ideological opponents of reforms who related negative effects of productivity to reforms.

Virmani hypothesized in a number of papers and books (since 2005), that this anomalous result was due to what was termed the "**J curve**" of major liberalization and growth " or subsequently the "J curve of Productivity and Growth." The significant modification to the S curve argument was that non-marginal/major reforms could give rise to obsolescence of skills, capital and technology in some industries, sub-sectors and sectors. This would be followed by a period of diversion of firm resources to learning new skills and technologies. Together these would, at least for a time, be larger than (or equal to) the positive effects of the reform on improved productivity from resource re-allocation to more productive use and the introduction new capital goods and technology, resulting in an overall net negative (non-positive) effect on productivity and growth, for a certain period after the reforms. This would yield the initial J portion of the curve. As sufficient new data gradually accumulated from 2006, it become possible to statistically confirm at the aggregate level that the J pattern was indeed emerging in terms of the overall growth of the Indian economy. In fact the economy completed the rising portion of the J curve by 2007-8 and entered the upper portion of the S curve thereafter.

The authors previously investigated the J curve hypothesis for the (organized) manufacturing sector and concluded that it was entering the upper portion of the J curve. However there was insufficient data at that time to categorically confirm that it had done so. The present study was able to demonstrate quite convincingly that total factor productivity growth (TFPG) in this sector had indeed followed a J curve pattern as a consequence of the 1990s reforms. We also found that partial factor productivity of capital, materials and services followed a J-curve pattern. As shown in the appendix, the analysis underlying the J curve is linked to obsolescence of capital goods and the technology embodied in them. What these results suggest is that there is complimentary capital goods-material-service package needed to produce new types-quality of goods. In contrast the partial factor productivity of labor and energy increased progressively during the 1990s and 2000s, the former because of capital deepening and the latter because of access to more energy efficient technologies and capital goods (S curve effects of reforms). Manufacturing output growth too followed the J-curve. While productivity growth undoubtedly had a major role in this, other sources of output growth, namely capital, labor, energy, materials and services, too accentuated the J-pattern. Owing to dominance in production process and its close link to output changes, materials input had the largest impact on the pattern of output growth, followed by services and capital inputs.

Trend in productivity growth at the sub-sector level of manufacturing showed a much more varied pattern of productivity growth than at aggregate level. This is to be expected in a situation in which different policy reforms affect different industries to different degrees and all reforms do not occur in one big bang. Given the rigid labour laws and heavily constrained labor mobility, some of the quickest positive effects of reform seem to have come from an increase in the proportion of output produced by

private sector vis-à-vis the public sector. We would expect these gains to be highest where the pre-reform productivity differential and share of public sector was highest. This issue needs to be examined further in subsequent research. In the case of India there was also a conscious, though necessarily imperfect, attempt to sequence the reforms to maximize the benefit-cost ratio (costs included the risks of negative socio-economic impact). One instance of this was the time pattern of removal of QRs/import controls and reduction of import duties/tariffs. This seems to have been successful in temporarily maintaining or raising effective protection in some sectors and thus allowing an initial acceleration in TFPG before the J-curve effect hit the sub-sector after effective protection returned to average-normal levels. The third factor was the technology gap between global best practice and Indian pre-reform levels, with the J curve effect expected to be stronger in industries in which the gap was larger. However, the application of this factor was tempered by the effects of the labor policy, which applies most rigidly to firms with 100 or more workers. In industries characterized by small scale labor intensive firms subject to less rigid labor laws, the technology-productivity incentive of a large gap with global best practice linked to larger scale (> 100 workers) was partially or wholly offset by the disincentive of getting stuck with a large numbers of workers.

Of the twenty two major and minor sub-sectors of manufacturing for which this paper estimated TFPG, three followed an S-curve pattern (14%), eight followed a J curve pattern (36%), and ten followed a hybrid S-J pattern (45%). In the last case, data for subsequent periods will be needed to confirm whether these sectors return to the right half of the S pattern (with the left half having occurred in the beginning). One sub-sector followed a pattern of falling productivity that suggests that it may not be viable in an open economy (5%). The leftist hypothesis that reforms and opening of the Indian economy damaged the Indian manufacturing sector can be decisively rejected.

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Appendix: J Curve of Import Liberalization and Productivity Change[14]

Import Liberalization

By definition, import liberalization and reform changes relative prices from the distorted domestic ratios to World relative prices. Highly protected goods would have relatively higher prices and would grow faster in a distorted economy thus giving them a higher weight in production at the start of reforms. With liberalization and opening, their prices and growth rate will fall, temporarily even to negative. At the same time the output and growth of previously under-protected goods would rise. Any Laspeyres type quantity indices will understate the (true change in) growth rate. Thus conventionally measured growth rates may understate the true growth rate during the reform period. A shift in the base year to a post reform year will raise the post reform growth rate and reduce the pre-reform one, reflecting the effect of reforms more accurately.

If reforms are slow and gradual, relative prices change gradually and producers adapt by stopping investment in unprofitable product lines and initiating it in newly profitable ones. The former is limited by the rate of depreciation and the latter by the pace of incremental technical change. If reforms are dramatic the effect can be significant. In a heavily protected economy, a major import liberalization will initially slow measured productivity growth and result in its acceleration only after a lag.

Major Import Liberalization and Productivity

Major Import liberalization can lead to a drastic change in product specific competitive advantage. Because of capital immobility, the capital employed in uncompetitive product lines become redundant and capacity utilization falls. If productivity calculations use capital stock measures based on the accumulation method with no adjustment for capacity utilization, calculated productivity will decline in these product lines. Though this will be partially offset by better capacity utilization in lines that have become more competitive, full utilization of the new potential requires adoption of new technology including investment in new capital goods (producing better quality output). The introduction of completely new (unfamiliar) technology will have short term negative effects while the positive productivity effects will take time to emerge, including the time taken to diffuse technology-S curve(see below for reasons). This results in what may be called the J-curve of liberalization-productivity, by analogy with the J-curve of the impact of exchange rate changes on trade. This is one of the reasons why studies show a fall in total factor productivity growth in registered manufacturing during the 1990s. It also explains why acceleration of aggregate TFPG and GDP growth rate has been so low.

We know from the Innovation literature that incremental change can have a different effect from major ("drastic") inventions. The latter "can trigger an uneven

[14] Based (with extensive paraphrasing) on Virmani (2005) who formulated the J curve hypothesis and Virmani (2006c), which elaborated it.

growth trajectory, which starts with a prolonged slowdown followed by a fast acceleration" (Helpman (2004)). There are many possible reasons for this. Hornstein and Krusell (1996) and Greenwood and Yorokolgu (1997) argued that adoption of new technologies requires firms to learn how to use them and this slows down productivity growth. Helpman and Trajtenberg (1998) argued that it takes time and resources to develop complementary inputs and during this time the diversion of resources slows down growth. Helpman and Rangel (1999) argued that on-the-job training that raises the productivity of workers also means that technology specific skills are lost when a new technology replaces an old one. Labor productivity would therefore decline temporarily. All these arguments have been used to explain the decline in productivity growth in the post-oil crises period (Helpman (2004)). The experience of Indian Import liberalization leads to the conclusion that major import liberalization can have similar effects.

Dynamic Competition and Growth

The market reforms that appear to have had the strongest dynamic effects in India are those relating to production, investment and external controls. These are best understood through the prism of competition.[15] For this purpose we distinguish three aspects of competition: The freedom to compete, the pressure to compete (competitive pressure) and the means and ability to compete. In a normal market economy freedom to compete is taken for granted. India created a system of production and investment controls and in some cases price and distribution controls that restricted or eliminated the freedom of medium-large firms to compete. As exploitation of economies of scale was an important characteristic of modernization, limits on size effectively limited the freedom of such firms to compete globally.

The pressure to compete (competitive pressure) can come from two sources: Domestic production or from imported supplies. In the first case domestic production can be by indigenous entrepreneurs or through FDI (more below). Entry of FDI can put competitive pressure on entrepreneurs, while imports can put pressure on both types of producers.

The threat of imports can sometimes be as powerful as actual imports. Thus the creation of artificial monopoly, an exclusive license to produce non-tradable services or to produce a tradable good with a complete ban on imports, eliminates actual as well as potential competition. In contrast a monopoly arising from market structure for instance a small market size relative to minimum efficient scale always has a potential competitive threat. Similarly an import ban or QR eliminates not just imports but the threat of imports. With imports free a custom Tariff, even one that is high enough to eliminate actual imports, puts some competitive pressure on domestic producers as it does not extinguish the threat of imports. Thus we can have a paradoxical situation in which an overall liberalization of import controls coupled with a rise in average tariffs can increase competitive pressure dramatically. The rise in tariffs on products subject to QRs by

[15] Porter (1995) had emphasized the importance of competition in developing and sustaining the competitiveness of firms on which the competitive strength of countries was built.

reducing rents, evasion and corruption reduces transaction cost of imports and thus multiplies the positive effect of a liberalization of these quantitative restrictions (QRs). This is what happened during the eighties.

The third dimension of competition is the means to compete. This has two aspects. Competition requires access to the inputs and capital goods that a firm needs to increase its ability to compete. It also requires access to factors (technology, capital, skills) and the flexibility to adjust them (unskilled labor). FDI by bundling many of these improves not only the ability of the nation to compete, but also strengthens the ability of domestic entrepreneurs through spillover effects. In contrast to abstract theoretical benefits of technology or exports, FDI demonstrates in practice the gains from new technology, management techniques, new products and new markets (exports). The spillover effects can therefore enhance the ability of domestic entrepreneurs to compete. [16]

Freedom to import inputs and capital goods not only puts competitive pressure on producers but also expands the means available to the producer to compete. Freedom to import consumer goods on the other hand puts competitive pressure on producers but does not directly provide the means to compete in the short run. However, it increases the information flow about product innovations and enhances knowledge about new materials and technology that are incorporated in it, thus increasing competitive ability in the long run.

FDI that bundles technology, management, marketing skills (including export marketing) and capital can rapidly expand a country's access to all these factors. In a country with a relatively high number and quality of entrepreneurs, such as India, FDI is most effective in modern industries and new products. In other words, *the positive effect of FDI is the highest where controls have created the largest gap between the domestic and global technology level.* These are likely to be the industries and products which have had the largest technological change globally. "Technology" includes management and marketing techniques and system relevant to the industry/product. International spill over of knowledge are critical to the growth of all countries and the importance increases the less advanced the country.

Broad and Deep Reforms and Growth

The nineties in contrast to the eighties were marked by a broad array of reforms the effects of, which on aggregate growth were much more gradual. There are a number of reasons for this. First, some of these reforms were static in nature and were not expected to impact growth or TFPG over the short-medium term. Such reforms may result in an increase in efficiency and/or equity leading to welfare improvements, but any growth impacts are likely to occur with a long and variable lag. The 1990s tax reforms (primarily income tax) were of this nature and were expected to lead to a sustainable increase in revenues.[17] Similarly most of the financial reforms have improved the health and stability of the financial system and improved the allocation of funds (static

[16] See Virmani (2005) or Virmani (2006b, c) for empirical details of productivity enhancing effects of FDI.
[17] Interestingly the polices that continued to worsen during the 1980s were also static in nature and therefore did not undermine the positive dynamic effects of decontrol policies.

efficiency, welfare). Reforms that will increase competitive supply of funds to new entrepreneurs, credit rationed producers and (direct) investors have been limited.[18]

Second, the increase in the pressure to compete has been higher, relative to the increase in access to the means to compete, in the 1990s than in the 1980s. This imbalance would not have emerged if recommended factor market reforms (labor, risk capital and debt finance, bankruptcy law, technology) had been implemented. Third a sharp reduction in protection gives rise to a *J-curve of productivity and growth*, an initial negative impact on measured productivity that is gradually exceeded by slowly rising factor productivity. There are several elements in the J curve of productivity and Growth following major liberalization: One, the rebalancing of historically distorted prices, which raise (lower) the relative price (weight) of previously slow (fast) growing sectors. Two, the immediate reduction in capacity utilization in unprofitable product lines due to capital immobility, till depreciation eliminates the excess capacity. Three, gestation lags in investment in newly profitable product lines and the S curve of technology diffusion that slows productivity improvements. Four, the resources and effort needed to adopt unfamiliar technology that may reduce the productivity of existing technology/capital.

Based on the pre- 1999-2000 NAS GDP data series Virmani (2005a) made the following prediction: "However it shows that the underlying trend growth is currently about 6.3% (6.25% to 6.35%). Thus the underlying medium term growth rate has been rising since the BOP crisis of 1990 and is now around 6.3%. It is likely to rise to about 6.5% over the next few years as the effect of the 1990s reforms works through the system as hypothesized in our analysis of the J-curve of liberalization." Once the new 1999-2000 based NAS GDP series became available in 2006 the rising growth trend was found to be statistically significant for aggregate growth, and the forecast for underlying growth was also revised upward. In Virmani (2009) the underlying growth rate of the Indian economy was estimated to be between 8.5% and 9%.

[18] Reforms such as competition enhancing diversity of ownership of deposit based Bank, as 70% of banks are still owned ($\geq$51%) by the government.