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Working Paper

Manufacturing productivity under varying trade regmies: India in the 1980s and 1990s

Working Paper, No. 107

Provided in Cooperation with:
Indian Council for Research on International Economic Relations (ICRIER)

Suggested Citation: Das, Deb Kusum (2003) : Manufacturing productivity under varying trade regmies: India in the 1980s and 1990s, Working Paper, No. 107, Indian Council for Research on International Economic Relations (ICRIER), New Delhi

This Version is available at:
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WORKING PAPER NO. 107

MANUFACTURING PRODUCTIVITY UNDER VARYING TRADE REGIMES: INDIA IN THE 1980s AND 1990s

DEB KUSUM DAS

July 2003

INDIAN COUNCIL FOR RESEARCH ON INTERNATIONAL ECONOMIC RELATIONS
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Foreword

This paper forms a part of a larger study on *Productivity Growth and Trade Regimes: A Study of Indian Manufacturing Industries in the 1980s and 1990s*, being undertaken at ICRIER. Following changes in India's trade policy stance in the 1980s and 1990s, the linkage between trade liberalization and productivity growth as an indicator of industrial performance has assumed importance. To this end the study seeks to explore the nature and magnitude of total factor productivity (TFP) change under different trade regimes.

The standard growth accounting methodology is applied to data compiled from the Annual Survey of Industries for selected 3-digit use-based manufacturing sectors over the period 1980-2000. The analysis focuses on the overall period and four sub periods (1980-85, 1986-90, 1991-95 and 1996-00) to reflect the shifts in trade policy regime. There is no evidence of much change in total factor productivity growth following liberalization of the regime initiated in the early 1990s. As in the 1980s, factor accumulation rather than productivity growth accounts for most of the output growth during this period.

Like many other studies on India and globally, this paper finds negative TFP growth, based on invested capital, in many industries over certain periods. It is difficult to conceive of negative technical change (exogenous or endogenous) and therefore negative TFP change must represent underlying structural and cyclical factors that need to be investigated and understood. Such structural factors would include exit restrictions arising from inability to dismiss workers or declare bankruptcy. Such exit restrictions result in accumulation of sick firms that pull down the industry TFP growth into negative territory. Other potential structural changes are sharp reductions in quantitative restrictions and tariffs that change relative prices from a protective configuration to world levels. In such a situation the measurement of TFP growth at world relative prices may diverge significantly from TFP growth measured in domestic prices (adjusted for aggregate inflation). Cyclical movements would also affect utilization of capital (and even unskilled labor, which is a quasi-fixed factor if retrenchment is not possible) over the cycle thus raising the possibility of negative TFP growth in a period of rising excess capacity. Reforms that improve animal spirits and sharply raise investments, as during 1994–95 to 1996–97 could perversely lead to higher excess capacity and lower measured TFP.

Arvind Virmani
Director & Chief Executive
ICRIER

July 2003

MANUFACTURING PRODUCTIVITY UNDER VARYING TRADE REGIMES: INDIA IN THE 1980s AND 1990s*

DEB KUSUM DAS

1. Introduction**

Industrial performance has been a subject of debate in India since the advent in the early 1950s of import substitution and industrialization strategy based on public sector as the engine of growth. Following changes in trade policy stance in the 1980s and 1990s, the linkage between trade liberalization and productivity growth as an indicator of industrial performance has assumed importance. The 1980s saw changes in the external and the industrial sector in matters pertaining to licensing for scale and technology as well as quantitative restrictions on imports and tariff rates. The 1990s brought about comprehensive trade liberalization encompassing abolition of non-tariff barriers, reduction of peak tariff rates and dispersion along with devaluation of the rupee. Against this background, it is important to analyze the impact of the economic liberalization on manufacturing productivity in the industrial sector. More importantly, in the context of policy reforms, we need to assess whether there was any beneficial impact on productivity growth of trade liberalization. To this end our study seeks to explore the nature and magnitude of total factor productivity (TFP) change under different trade regimes.

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* This paper forms a part of a larger study on "Productivity Growth and Trade Regimes: A Study of Manufacturing Industries in the 1980s and 1990s" being undertaken at Indian Council for Research on International Economic Relations (ICRIER). I am thankful to Professors K.L.Krishna, Suresh D. Tendulkar, and B.N Goldar for extensive comments on earlier drafts of the paper. Helpful comments from Professors Arvind Virmani and Shankar Acharya, during a presentation at ICRIER are gratefully acknowledged. I am also greatly indebted to Professor Prema-Chandra Athukorala for valuable insights and advice. Finally, research assistance by Sasanka Sarmah is gratefully acknowledged. The usual disclaimers apply. Please address any comments to debkusum@icrier.res.in

** The paper examines productivity performance of Indian manufacturing under varying trade regimes. The standard growth accounting methodology is applied to data compiled from the Annual Survey of Industries for selected 3-digit use-based manufacturing sectors over the period 1980-2000. The analysis focuses on the overall period and four sub periods (1980-85, 1986-90, 1991-95 and 1996-00) to reflect the shifts in trade policy regime. There is no evidence of much change in total factor productivity growth following liberalization of the regime initiated in the early 1990s. As in the 1980s, factor accumulation rather than productivity growth accounts for most of the output growth during this period.

The performance of the Indian industry, somewhat encouraging with respect to overall growth and diversification, has been poor when judged in terms of productivity growth. Though the performance of Indian industries in terms of productivity growth has been documented to be unsatisfactory, there have been very few attempts at analyzing the factors behind the insignificant productivity growth[1]. The analysis in Ahluwalia (1991, 94) draws some tentative conclusions about the role of industrial and trade policies in bringing about the turn around in productivity growth. Our appraisal of the studies shows that the question of "turn-around" dominated the analysis of the productivity growth performance of the 1980s[2] and the issue of whether there was an improvement in the early 1980s is still far from resolved. The evidence for the 1990s however confirms that there has been a fall in TFP growth rate in the 1990s relative to the 1980s. The evidence of a decline in the 1990s holds across different data sets (ASI, RBI) as well as levels of disaggregation- firm and industry. Further, the estimates are quite robust to the alternative methodologies for measuring productivity.

The question of why the TFP growth in the manufacturing industries declined in the 1990s assumes significance as an important objective of the reforms in the 1990s was to make Indian industries competitive in international markets and enhancing productivity growth constituted a means to that end. There could be several possible inferences. First, the failure of TFP growth to accelerate with the economic liberalization is perhaps indicative of the harmful lag effects of the previous interventionist regime. Second, since there was a spurt in investment activity in the 1990s in response to the economic reforms, there could be an immediate adverse effect due to gestation lags.

The paper is organized as follows. The following section provides an over view of the policy regimes facing the manufacturing sector in the 1980s and 1990s. Section 3 deals with the methodology and database of productivity growth measurement.

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[1] Studies by Parhi (1997) and Mitra et al (1998) have examined the role of factors like R&D, Infrastructure etc in productivity growth. A large number of studies have however addressed the methodological issues in estimating manufacturing productivity and debating the "turnaround" phenomenon,

[2] See Das (2001) for a review of the recent studies on productivity growth in Indian manufacturing in the 1980s and 1990s.

Productivity growth estimates for the 1980s and 1990s are documented and analyzed in section 4. Section 5 concludes the study.

2. Trade Regimes and Indian Industry: 1980s and 1990s

The policy regime facing the manufacturing sector in developing countries is often a major constraint in attaining high levels of efficiency. In particular, trade and industrial policies play a crucial role in shaping the manufacturing sector's growth. India's economic policies towards industry and manufacturing sector have had a large measure of success in the development of a diversified industrial base. Nevertheless these policies have also carried with it some costs- low productivity and lack of competitiveness.[3]

The industrial stagnation that marked the period from the mid-1960s to the late 70s led to rethinking on the role of trade-policy in India [Alexander (1977), Hussain (1984) and Narasimham (1984)]. Up to the 1970s the focus of trade policy was on regulating the utilization of foreign exchange through the use of quantitative restrictions. The import control system divided imports into three broad categories- intermediate inputs (raw materials, components, spares and supplies), capital goods and consumer products.[4] Consumer goods other than those imported via state agencies (food-grains, edible oils, certain drugs and pharmaceuticals medicines) and canalized were not permitted. Other imports were listed as non-permissible, limited permissible, automatic permissible and those in open general list subject to tariff rates applicable. This implied licensing for all categories of imports except those on OGL.[5] Two important categories of import licenses were the 'actual-users' (AU) licenses for import of intermediate and raw materials and 'capital goods' (CG) licenses for import of capital goods. These were non-

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[3] See World Bank (1989), Dhar (1990) for an appraisal of the policy regime in India in the 1980s.

[4] See the chart on India's Import Control Mechanism-1975-76 in Narahari Rao (1985) and also reproduced as figures 5.1 and 5.2 in chapter 5 of Srinivasan (1993).

[5] OGL refers to Open General License, an import-licensing scheme, where a product is available for imports against tariff. CANALIZED means that imports are only allowed by the government or any of its agencies

transferable and required the fulfillment of two criteria: (i) the 'essentiality' of the proposed import and (ii) 'indigenous' non-availability of the proposed import. The actual allocation across industries and firms within an industry were *ad hoc,* based on bureaucratic perceptions of 'fairness' and 'equity'.

The 1980s witnessed some changes in the trade regime with regard to imports of intermediate inputs and capital goods with many items of intermediate inputs and capital goods being brought under the OGL. Further, even small-scale units were free to import raw materials covered in the OGL category. Imports were also allowed for certain canalized products. The 1982-83 trade policy raised the value limit for imports to promote technological up gradation and modernization under the technical development fund scheme to US$ 500,000. Access to foreign exchange for improvement of technology by way of import of know-how, designs and consultancy was also improved in certain cases. The reforms initiated in 1985 made an attempt to bring stability and continuity in the external sector by spelling out a three-year trade policy (1985-88). The expansion of items under the OGL lists was backed up by removal of QRs and their replacements by tariffs on non-competitive imports. Amongst the products, more items of machinery were brought under the free category. Further imports of capital goods against replenishment licenses were granted to both small-scale and non small-scale units whose exports of select products were less than the minimum prescribed ten percent of their production. A significant feature of the 1988-91 export-import policy was the provision for 'flexibility' in regard to the Replenishment (REP) license, which was freely transferable. REP licenses were automatically endorsed for a certain degree of flexibility permitting import of limited permissible and canalized items. The range of export products qualifying for import replenishment has also widened. Further additions were made in the OGL in 1989-90 in terms of capital goods required for manufacturing footwear (rubber and canvas) and silk items.

The 1991-92 trade reforms have been well documented [Mishra and Goldar (1996), Joshi and Little (1994), Chadha (2000)]. We concentrate on three aspects of the 1991 trade-reform package: removal of quantitative restrictions, lowering and

rationalizing of tariffs and export subsidies. The major change in the trade policy of 1992-97 is a negative list of products banned due to health, defense and environmental concerns. Except for consumer goods, almost all items of capital and intermediate goods can be freely imported subject to tariffs. The imports of some restricted items, has been liberalized by permitting their imports to certain categories of exporters through freely transferable special import licenses [around 300 items allowed to be imported via special import license (SIL) in 1991-92]. Further, all second-hand capital goods having a minimum residual life of 5 years are free to be imported. Comparing the periods 1986-90 and 1991-95 we observe that a high proportion of items (in terms of value of imports and number) have been freed from the restrictions of import licensing.[6]

Prior to 1991, import tariffs in India were amongst the highest in the world. The removal of quantitative restrictions on imports was accompanied by a gradual lowering of import duties in each of the budgets presented from 1991 onwards. The maximum tariff rate was lowered from a peak of 355 per cent in 1990-91 to around 40 per cent by the year 1999-00. The rate for the manufacturing sector was reduced to 30 per cent in 1999-00 from a high of around 125 per cent before the 1991 trade policy changes. The reductions in import duty rates were especially sharp for capital goods. The composite duty rate on "project imports" (imports of various capital goods needed to set up new projects) was lowered from 85 per cent to around 25 per cent. There is an even lower rate of 20 per cent applicable for machinery for electricity generation, petroleum refining, coal mining and zero for machinery for fertilizer projects. A number of changes were also made to simplify the system- reduction in inter-product variations and rationalization of the tariff structure. In addition, many end-use exemptions were removed. As a result of the tariff reforms, the collection rate of duty at the aggregate level fell from 47 per cent in 1990-91 to 30 per cent in 1999-00.

[6] See Table 8 in Mishra and Goldar (1996), wherein the HS codes subject to OGL increased from 13 percent in 1987-88 to 55 percent in 1994-95. Further, the frequency distribution for 1987-88 shows that around 29 percent of HS codes are in unidentified category as the licensing status could not be ascertained, whereas no such ambiguity was reported for 1994-95.

India does not provide direct subsidies to exporters, however there are duty and tax concessions, export-finance, marketing and promotion. Between the 1970s and 1980s, a number of incentives were designed to compensate exporters for the cost escalating effects of domestic taxes. The negative list for exports was significantly pruned removing a number of restrictions earlier applicable on exports, particularly of agricultural products (items subject to export controls were reduced from 439 to 215 by 1993-94). The emphasis of the export incentive system has been changed considerably since 1991. The role of duty free import licenses for exporters was enhanced since 1991 through the lists of products with published physical input-output norms to facilitate computation of values of duty-free import licenses. A new class of value-based duty exempt import licenses was introduced in which exporters could import materials of his choice, rather than pre-defined precise values of certain categories of import, up to the permitted foreign exchange value of the licenses. A special scheme known as Export Promotion Capital Goods (EPCG) originally introduced in 1990s was liberalized in 1992 to encourage imports of capital goods. The concessional import duty was reduced from 25 per cent to 15 per cent.

We can discern 4 distinct phases of India' s trade liberalization, in the study period. The first phase saw the emergence of thinking about the need for change in trade policies as discussed in above. The second phase starts with the Long Term Fiscal Policy proposing the removal of import licensing and simplification of the tariff structure and, importantly, the first instance of a 3-year trade policy. The third phase starts with the comprehensive trade policy changes in 1991-92. The final phase starts with the EXIM Policy of 1997-2002 that aims at simplified procedures and rationalized tariff rates. The major changes in export and import policies during the four phases of trade reform are in Table1.

Table 1: Import and Export Policy Changes in the four Trade Reform Phases

Phase-1: 1980-85	Phase-2: 1986-90	Phase-3: 1991-95	Phase-4: 1996-00
• OGL items not on the banned list can be allowed on essentiality and indigenous clearance • REP licenses to registered exporters made transferable • REP licenses issued to manufacturer–exporters whether they export directly or through others • Advance license with benefit of custom duty exemption was extended to new products and new markets • Setting up of Trading Houses for exports • Trading houses were allowed access to restricted and canalized items • Value of imports to promote technological up-gradations doubled to US $500,000 • Imports of raw materials by SSI under OGL allowed • Facility for import of certain canalized items allowed.	• Greater role by removing QR for tariff in regulating imports • Abolition of advance licenses • Items under OGL expanded • More items de-canalized • Expansion in capital goods lists under OGL including machinery • Imports of capital goods against REP licenses granted to SSI/ non-SSI • Import of capital goods for NRI to set up industries • Import of machinery and raw material for export promotion in thrust areas • Exports under barter deals [East Europe] eligible for REP benefits • Concessions for export oriented units & Free Trade Zones • export-import (XM) pass book for manufacturer exporter	• Import control via licensing eliminated except for a negative list of mostly consumer goods • REP system was enlarged and restructured • Capital goods, raw materials and components may be imported by any person whether AU or not • All second hand capital goods having a min residual life of 5 years may be imported by the AU without a license • Some imports of consumer goods allowed • Imports of consumer goods under SIL • Number of items subject to export control reduced • Several incentives available to exporters • Tariffs were lowered and rationalized • Peak duty rates lowered in stages from 150 to 50% • Duty rate on capital goods lowered from 85 to 25%	• Peak tariff rates reduced • Lists of freely importable consumer goods expanded • Transferability of import licenses liberalized • More items put on OGL • Import of gold and silver liberalized • Basic customs duties on IT sectors rationalized • Special additional customs duty imposed • Further rationalization of peak tariff rates to around 30 percent

Source: Economic Survey, Government of India- Various Years

Industrial Policy Changes

The stagnation of industrial production in the late 1970s induced some thinking on the industrial policies and there was recognition of the need for reforms in industrial

sector to complement any foreign trade liberalization attempts. The 1980s witnessed a wide array of initiatives aimed at creating a dynamic industrial environment. The thrusts of these reforms were to lower some of the policy induced entry barriers in a number of industries. Second, these reforms were aimed at offering larger discretion and decision making to corporate managers without reference to government machinery. Third, minimum efficient scales were announced for various industries for attaining international competitiveness. These changes also may be seen as the first step in removing the preemptive claims of the government in undertaking production in pre-designated sectors of industrial activity. The internal liberalization package included measures such as- automatic endorsement of capacity expansion up to 25 percent of licensed capacity, broad-banding of industrial licensing to allow firms to overcome a tightly defined product specification, de-reservation of 40 industries and permitting large firms to enter, raising the investment limits for inclusion in SSI limits, revising the ceiling upwards for inclusion in MRTP classification and de-licensing of several industries especially if these capacities are established in back ward areas or dedicated predominantly for exports. Further, policies for specific sectors were also initiated.[7]

In 1985, firms with assets below Rs 50 million and located at least 30 miles beyond urban areas no longer required a license. By 1988, this limit was raised to Rs 150 million and to Rs 500 million for industries located in 'backward' areas. In addition, 25 broad categories of industries were de-licensed subject to the conditions that they were not covered under (1) Monopolies Restrictive Trade Practices Act [MRTP] (2) Foreign Exchange Regulation Act [FERA]. (3) Small-scale industries reservation and (4) not located in urban setting[8]. For many industries, which remained within the ambit of licensing, the facility of broad banding was accorded to allow them to make rapid changes in their product-mix. Broad banding was also extended in stages and some 28 industry-groups were covered by the 1986.A provision was also made for capacity re-

[7] Aside from general policy thrust, the government announced a new textile policy and as a follow up to the new textile policy, licensing policies for synthetic yarns and fibres have also been liberalized. Steps have also been taken to strengthen the business environment for the electronics industry with a liberalized policy framework.

[8] See Table 4.1 of Economic Survey (1985-86) for the list of 25 broad categories of industries. In June 1985, de-licensing was extended to drugs and pharmaceutical products.

endorsement to all licensed units, which achieved 80 percent of their licensed capacity during any of the previous five years ending 31st March 1985.[9] Further more, some firms even after capacity increases through re-endorsement were left at uneconomic scales of operation. The government invited proposals for these firms, to expand up to minimum economic scales without the need for licenses.

The MRTP act was also rationalized. The asset threshold bringing a unit under the purview of the MRTP act was raised to Rs100 crores taking into account the price increases since 1969. In addition, the government also permitted 30 broad group of industries to seek a license from Industrial Development Regulatory Agency without obtaining a clearance from the Department of Company Affairs for a new project or substantial expansion. Further, FERA and MRTP companies were allowed to continue to be permitted if the product was predominantly for exports with an export share of 60 percent (75 percent if the item was reserved for the small-scale sector). To promote industrialization in backward areas, conditions permitting these industries in such areas were also liberalized.

Three aspects of the industrial reforms in the 1990s merit attention. First, the across the board de-licensing and the repealing of the MRTP act, reducing the barriers to entry into the industrial sector. Firms are now free to manufacture any article except those subject to compulsory licensing in response to market signals since industrial licensing for capacity has been removed. . The licensing requirement has been abolished in all but 15 industries where strategic and environmental concerns dominate or the import content is very high. This was done with the purpose of increasing the role of commercial considerations in investment planning apart from reducing the bureaucratic discretion. Second, clear articulation of policy with respect to reforming the public sector and subjecting certain industries hitherto reserved exclusively for the public sector to competition from the private entrepreneurs. The number of areas reserved for public

[9] The capacity on their licenses will be endorsed to the extent of the highest production achieved during any of the previous years plus one-third thereof. The facility is however not available to small-scale sector or certain identified industries characterized as suffering from shortage of raw materials, infrastructure or pollution levels or industrial setups in urban locales or MRTP/FERA companies.

sector is reduced to six- defense, atomic energy, minerals for atomic energy, coal, mineral oils and railway transport. Even in sectors reserved for public sector, private investment is permitted on a case-by-case basis. Finally, freeing of restrictions on foreign collaborations, technical as well as financial. The new policy provides for automatic approval of FDI up to 51 percent foreign equity holding in 35 specified high priority, capital- intensive, high-technology industries. The foreign equity should cover the foreign exchange involved in importing capital goods and outflow on account of dividend payments and is balanced by export earnings over a period of 7 years from the commencement of production. The barriers to exit however still remain a problem, as Board for Industrial and Financial Reconstruction (BIFR), Companies Act and Urban Land Ceiling Act stood in the way of providing the necessary flexibility in re-deploying resources from the unproductive and economically non-viable sectors to the more vibrant sectors.

3. Methodology and Data base

Growth stems from two sources: factor accumulation and productivity growth. The basic issue is the relative importance of each of these components .The concept of productivity used in this study is that of total factor productivity (TFP)[10]. Productivity is a technical concept, which refers to a ratio of output to input, a measure of the efficiency with which the factors of production are used. Whereas conventional measures of productivity such as labor productivity and capital productivity suffer from the drawbacks of including gains in efficiency due to an increase in availability of other inputs, The TFP measure attempts to avoid this problem by taking into account the usage of all inputs. The index of productivity is defined as output per unit of the composite of all factors of production. The question arises as to how to weight the inputs in the index. It is in this sense that the notion of TFP becomes theory dependent. For classification purposes, we can conceptualize the notion of TFP through an index or through a production function. Solow (1957) proposed the economic theory of production as the explicit analytical framework for TFP measurement. He defined TFP growth as the shift

[10] See Diewert (1992) for a review of the notion of TFP and its computations.

in an aggregate production function and since then the technique has been used extensively to analyze technological change in both developed and developing countries.[11]

Two important methodologies used in most studies on productivity growth have been growth accounting and the econometric estimation of production functions. The objective of the growth accounting technique is to determine how much output growth is due to accumulation of inputs and how much can be attributed to technical progress. In other words, how much of growth can be explained by movements along a production function and how much should be attributed to advances in technological and organizational competence. The rationale for the growth accounting approach depends not only on the existence of the aggregate production function for the sector or economy, but also on the validity of the marginal productivity theory of factor pricing. Therefore direct estimation of the aggregate production function is an alternative.[12] However, a major limitation is that the coefficients to be estimated must be treated as constants over the data samples used in estimation. If flexible functional forms are adopted because more parameters have to be estimated larger samples are needed.

3.1 Productivity Growth at the Industry Level: Jorgenson Methodology

The existence of the aggregate production function imposes stringent conditions on the production patterns at the industry level. Jorgenson (1995) argued that these assumptions are incongruent with reality and data for sectoral production accounts can be generated in ways that avoid some of the more restrictive assumptions. In a sequence of papers that Jorgenson co-authored with Gollop (1980, 1983), with Fraumeni (1980,1986), and with Gollop and Frauemeni (1987), the aggregate production function is dispensed

[11] Advances in closely related areas of economic theory and measurements have strengthened the theoretical foundations of TFP measurement. Particularly relevant are advances in duality theory, including the work by Shepard (1953,70), Uzawa (1964) and McFadden (1966,78). Advances have also been made in the area of aggregation, e.g. in defining appropriate quantity and price indices of output, input and TFP. These contributions include those of Diewert (1976, 78).

[12] The estimation of production function (or other related producer behavioral equation) permits departure from some of the assumptions underlying the traditional growth accounting exercises, thus can provide a framework for testing some of these assumptions- constant returns to scale and perfect competition.

with and industry output growth is instead represented by an industry level function of capital, labor and intermediate inputs as well as industry level productivity. The growth of output at the sectoral aggregate level is allocated between the contribution of inputs and changes in productivity. The contribution of each input to growth is separated into its quantity components and growth in input quality.

The TFPG estimation in this study follows the methodology developed in Joregenson et al (1987) which ultimately rests on Solow (1957) 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 latter in turn equals the sum of the value share weighted growth rates of individual inputs. The assumptions on which the approach rests are that the producers are price takers in both output and input markets, so that output prices are equal to the marginal costs of production and that the technology is characterized by constant returns to scale.[13]

Following Jorgenson et al. (1987) we assume that for each industry there exists a production function relating output to labor, capital, materials, energy and time. For the ith industry,

$$Y_i = F^i(L_i, K_i, M_i, E_i, t), i=1,2,\ldots\ldots\ldots 75$$

Where Y is real gross output, L is labor input, K is real capital stock, M is real material input, E is real energy input and t is time. TFP growth for the ith industry in year t is calculated using the Tornqvist approximation as

[13] These assumptions enable the estimation of TFP growth without having to estimate the parameters of the production function, even when the data-set does not have a large number of time series observations In the light of the new growth theory [Romer (1986), Lucas (1988)] which emphasize externalities and learning effects, this approach may seem outdated. The new growth theories may affect the interpretation rather than the validity of the TFP calculations. Further, it is possible to use the estimates, derived on the assumptions of constant returns, absence of externalities, and so on, to test whether the patterns of productivity growth are indeed consistent with the assumptions.

$$Ln[TFP(t)/TFP(t-1)]=Ln[O(t)/O(t-1)]-\bar{v}_l(t)Ln[L(t)/L(t-1)]-\bar{v}_k(t)Ln[K(t)/K(t-1)]-\bar{v}_m(t)Ln[M(t)/M(t-1)]-\bar{v}_e(t)Ln[E(t)/E(t-1)]$$

where, $\bar{v}_l(t) = 1/2[v_l(t)+v_l(t-1)]$, $\bar{v}_k(t) = 1/2[v_k(t)+v_k(t-1)]$, $\bar{v}_m(t) = 1/2[v_m(t)+v_m(t-1)]$ and $\bar{v}_e(t) = 1/2[v_e(t) + v_e(t-1)]$

$\bar{v}_l$, $\bar{v}_k$, $\bar{v}_m$, and $\bar{v}_e$ are the averages of the shares of labor, capital, materials and energy for the years (t) and (t-1) as defined above The methodology assumes perfect competition and constant returns to scale. Further, the revenue shares of the factor inputs sum to unity.[14] The productivity growth estimates are computed for the full sample of 75 three-digit manufacturing industries as well as the use-based classification: intermediate, capital and consumer goods groups of industries.

3.2 Data and Variables

Data Description and Variables Construction

We consider a set of 75 three-digit manufacturing industries. The period of analysis is 1980-81 to 1999-00. The panel of 75 three-digit industries, cover the following two-digit industries- cotton textiles (23), textile products (26), leather and leather products (29), basic chemicals (30), rubber, plastics and petroleum products (31), basic metals (33), metal products (34), non electrical machinery (35), electrical machinery (36) and transport and equipment (37). The choice of the industries is guided by considerations of covering a wide range of industries, which have been the beneficiaries of the trade and industrial policy changes of the 1980s and 90s. Sectors like electrical and non electrical machinery, basic metal and metal products, chemicals, cotton textiles, textile products and leather have been chosen keeping in mind the our objective of exploring the trade liberalization- productivity linkage.

[14] Hall (1986,1988) argues that the measurement of productivity is likely to have pro-cyclical bias due to the assumptions of perfect competition and constant returns to scale. Studies by Harrison (1994), Srivastava (1996), Krishna and Mitra (1998) and Balakrishnan et.al (2000) have taken into account Hall's argument in computing TFPG.

The chosen industries account for a large percentage of manufacturing value added. Appendix Table A1 presents the value-added shares for four points of time- 1980-81, 1985-86, 1990-91 and 1995-96. In all four years, we observe that the 75 industries contribute over 65 percent of total manufacturing value added. These industries are further classified as intermediate, capital and consumer goods sectors comprising 30, 25 and 20 three-digit industries respectively. These industries cover the organized or the registered sector of manufacturing. It may be noted that till 1988-89 the classification of industries followed in ASI was based on the national industrial classification 1970 (NIC-1970). The switch to the NIC-1987 from the year 1989-90 necessitated some matching of the NIC-1970 with NIC-1987. We treated the NIC-1987 as the base and accordingly carried out data adjustment at the 3-digit industries level. Some industries had to be merged (302+306, 338+339, 343+349, 344+345, 363+364 and 365+366) to build a comparable series for pre 1989-90 and post 1989-90 periods. Rest of industries were adjusted using the procedure outlined in the CSO document (1987) to arrive at comparable series.

The basic source of data used for the productivity estimates is the *Annual Survey of Industries* (Central Statistical Organization, Government of India). Most of the earlier studies [e.g Goldar (1986a), Ahluwalia (1991), Mohan Rao (1996a)] have also used this as the principal database. For correcting the reported data on nominal gross output and intermediate inputs, suitable deflators have been constructed with the help of the official series on wholesale price indices (Index Number of Wholesale Prices in India, prepared by the Office of the Economic Advisor, Ministry of Industry, Government of India). For purposes of deflating the material and energy inputs, we needed to create a weighted price index. For this purpose, the appropriate weights were taken from the 115 sector input-output table for the years 1983-84, 1989-90 and 1993-94 (Central Statistical Organization, Government of India). For estimating the capital input series, estimates of the gross-net ratios to compute the capital stock for the bench- mark years were taken from the 1973-74 RBI bulletin. The deflator for the capital stock series was computed from the yearly volumes of the National Accounts Statistics (Central Statistical Organization, Government of India).

Construction of Variables

The basic variables for the estimation of the yearly TFP growth rates are gross output, capital stock, number of workers, materials consumed and energy consumed. To arrive at the measures of output and inputs in real terms, suitable deflators for the variables were constructed.

One of the important advances in the industry- level productivity measurement has been to utilize gross output rather than value-added as a measure of product at the industry level. Jorgenson argues that an important advantage of focusing on industry gross output for growth accounting is that intermediate inputs can be treated symmetrically with inputs of capital and labor. Griliches and Ringstad (1971) however have preferred gross value added to gross output, preference being based on various reasons cited in their work.[15] In the Indian case, a study by Balakrishan and Pushpangadan (1994) has shown that a gross value added measure using a single deflation procedure might produce a bias in the estimates if material prices do not move parallel to output prices. Gross output in the present study is defined as the ex-factory value of products and by-products manufactured during the accounting year. It also includes the receipts for industrial and non-industrial services rendered to others.

There are various arguments put forward while specifying a measure of labor input.[16] Total persons engaged in industrial units are used as the measure of labor input. For recent issues, it is reported in the ASI under the head "persons engaged", for earlier issues it is reported as "number of employees". This relates to all persons engaged by the

[15] Gollop and Jorgenson (1980), Griliches and Ringstad (1971) and Goldar (1986a) dicusses the choice between gross and net value added.

[16] Solow (1957) did consider treating workers with different skill level as a separate input factors and explicitly recognized that doing so would lead to a reduction in measured productivity residual. Jorgenson argues that hours worked for persons with different accumulated stocks of human capital must be weighted by their corresponding and presumably differing marginal products. Jorgenson's 1967 paper with Griliches presents a constant quality index for labor input focussing on differences in educational attainment amongst workers. Jorgenson's subsequent papers with Gollop (1980,83) produced constant quality indices of labor input for 51 industrial sectors of the US economy.

factory for wages or not in work directly connected or indirectly with the manufacturing process and includes administrative, technical, clerical staff as also labor used in production of capital assets for factory's own use. Implicit in such a measure is the assumption that workers and other than workers are perfect substitutes. This may not be a proper assumption to work with when the objective of the study is to compare the productivity growth across the industries and management is one of the vitally important factors in explaining inter-industry differentials.

Most studies do not consider intermediate inputs into account in that either a gross/net value added is used as measure of output. Jorgenson (1988) has shown that in a three input production framework, the contribution of intermediate input is the most significant source of output growth vis-a-vis capital and labour in the context of US economy. Intermediate input in our study consists of materials and energy inputs separately. Materials consumed represents the total delivered value of all items of raw material, components, chemicals, packing material and stores which actually entered the production of the firm during the accounting year. It however excludes all intermediate products, which are subject to further manufacturing process. The yearly fuels consumed are taken as a measure of energy input. Fuels represents the total purchases of fuels, lubricants, electricity, water by the firms during the accounting period. It excludes that part of fuels that is consumed by employees as apart of the amenities.

The Capital Stock Variable

The measurement of capital stock is the most complex of all input measurements. The conceptual problems involved in the measurement of capital input have been widely discussed by writers on productivity study.[17] Given the theoretical reservations, there are also wide differences in the actual methodology used to build the estimates of capital stock. The most widely used procedure is that of the "perpetual inventory method."[18]

[17] See Denison (1957), Ruggles and Ruggles (1967) and Griliches and Jorgenson (1967).

[18] Goldsmith (1951) advocated the perpetual inventory method. See Dan Usher (1980), Young and Musgrave (1980) as well as comments by Rhymes and Faucett for a critical appraisal of the perpetual inventory method.

Gross fixed capital stock series at constant prices was derived using the perpetual inventory method. To arrive at the real gross fixed capital stock, we need (1) an estimate of benchmark gross fixed capital stock, (2) time series on gross investment and (3) time series of capital goods price.

The benchmark gross fixed capital stock for the three-digit industries for the year 1973-74 is arrived at by multiplying the net fixed capital stock as reported in the ASI by the gross-net ratios as available from an RBI Bulletin. The gross-net ratios were available for some broad two-digit industries necessitating mapping between the two and three-digit sectors.[19] The benchmark real capital stock is computed by inflating with the average of the capital goods price for the period 1964-65 to 1974-75. For each industry, the yearly gross investment in current prices was computed, from the figures of book values of net fixed capital assets and depreciation reported in ASI.[20] The yearly gross investment is deflated by an index of capital goods price series with 1981-82=100 as base to arrive at a real gross investment series. The post benchmark real gross fixed capital stock is arrived at by the following procedure: real gross fixed capital stock (t) = real gross fixed capital stock (t-1) + real gross investment (t). The annual rate of discarding of the capital stock was assumed to be zero.

Deflators for the Variables in Nominal Values

Time series data on gross output, costs of intermediate inputs- material as well as energy and current price gross fixed capital stock have been deflated by suitable deflators (base 1981-82=100). Needless to say that construction of suitable deflators for gross output and intermediate inputs is crucial for the measurement of the productivity growth. The procedure followed for constructing the deflators is described below.

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[19] An alternative would have been to consider the gross-net ratios available from Hashim and Dadi (1970).

[20] Gross investment in year t denoted by I(t) is computed as I(t)= B(t)- B(t-1) + D(t), where B(t) is the book-value of fixed assets in year t and D(t) is depreciation of fixed assets in year t, both as reported in ASI

1. Gross Output: It was difficult to get an entirely satisfactory deflator for each of the 75 three-digit industries from the wholesale price statistics. Therefore for some industries we were required to construct a weighted average combining two or more wholesale price indices to arrive at a reasonably accurate deflator for the concerned industry.

2. Material Input: To compute a price series of material inputs, we need to have an idea about the type of materials used by industry groups. ASI does not provide a breakup of the materials consumed at the three-digit industry level. For our study, we established a mapping between ASI three-digit industries and the input- output table to identify the material inputs for each industry. We excluded sectors, which covered capital goods and energy respectively. The rest of the entries were identified as components of materials. The prominent materials are organic and inorganic chemicals, rubber, plastics, paints, synthetic fibers, other chemicals, nonmetallic mineral products, metal products, nonferrous metals, iron and steels, paper, wood and coal tar etc. In addition, there were also products specific to particular industry groups. On an average, there were around 20 entries per industry, which were classified as material components.

   For each industry, we constructed a weighted-index of material prices. Since each industry had a large number of material inputs, we had to draw upon several wholesale price indices to capture these inputs across industries. The weights for each of these components were computed from the 1983-84, 1989-90 and 1993-94 input-output tables and used for the years of the study[21]. It would be important to point out that such a procedure provides industry specific deflators for material inputs, which vary across industries as the structural coefficients are not uniform[22].

[21] The I-O table 1983-84 was used for the years 1980-81 till 1988-89, 1989-90 was used for the years 1989-90 till 1992-93 and 1993-94 was used for the years 1993-94 till 1999-00.

[22] Appendix Tables II.4A and B in Das (2001) provides a description of the major categories of material inputs across the industries and the list of WPI series used to approximate as closely as possible these material inputs.

3. Energy Input: For purposes of our study, the energy input comprises the following types: (1) coal [or lignite], (2) natural gas [or petroleum] and (3) electricity. Since the break up according to these categories was not available from the ASI database, a mapping was established with the I-O sector to have an idea about the weights of these categories. The relative weights were obtained from the 1983-84, 1989-90 and 1993-94 I-O tables and used for the period of the study. The wholesale price indices (base 1981-82=100) of coal, mineral oil and electricity were used for the three types of energy input.

4. Gross Fixed Capital Stock: A price deflator for capital goods is needed to deflate the yearly gross investment series. For our study, fixed capital was of two types: (1) structures and (2) equipment. We use construction and machinery & equipment to proxy for structures and equipment. The implicit price deflator for investment in construction and machinery & equipment (base 1981-82=100) is used to deflate the current rupee investment series. The price deflator is computed as the ratio of current price gross capital formation by type of assets to constant price gross capital formation by type of assets. The industry specific shares of buildings and plant & machinery in the total are used as weights for structures and equipment in computing a weighted implicit price deflator. The weights were obtained from the 1983-84 ASI and used for the entire period of study.

4. Productivity Growth Estimates: 1980s and 1990s

TFP growth rates are computed for 75 three-digit industries and three use-based industry groups for the four phases of trade reforms and the overall period 1980-2000.[23] We discuss the contribution of productivity change and input expansion in accounting for the industry' s output growth in the decades of 1980s and 1990s. We also document the

[23] The use-based classification used in this paper is based on Das (2001) which in turn largely reflects the Ahluwalia (1985) classification. Consumer goods is however inclusive of both consumer durable and non-durable.

magnitude and direction of productivity growth across different industries and use-based sectors for the four phases of trade reforms.

TFP growth or Factor Accumulation?

Our empirical estimates based on growth accounting at a detailed level for 75 three-digit industries on one hand and the use-based sectors on the other has clearly highlighted the TFP growth performance during the phases of trade reform. Table 2 shows the relative contribution of TFP growth and factor input growth in accounting for the growth of output during the decades of 1980s and 1990s as well as the 20-year period extending from 1980 till 2000. For all-industries, we note that the contribution of TFP is insignificant for the period 1980-2000. For the decade of 1980s, the contribution is a low 7 percent per annum whereas for the 1990s, it is insignificant.

Observing the individual three digit industries, we see that the TFP growth contribution is either negative or very insignificant across the two decades of trade reforms. For some industries, however the TFP growth contribution to output growth is substantial. For few industries in each decade, we also record more than 100 percent contribution from TFP growth. For the period 1980-00, only two industries record TFP growth contribution of 50 percent or more- weaving and finishing of cotton khadi (232) and tanning, curing and finishing of leather (290). Most of the machinery goods industries record low positive TFP contributions.

In conclusion, we see that in most of the industries increases in factor-input account for the observed growth in output. This holds true across the industries and the time periods. The TFP contribution also varies across different ranges of output growth.

Table 2: TFP contribution to Output Growth under Trade Reform Decades: Three Digit Industries

Three-Digit Industry Descriptions NIC-87	Decade of 1980s		Decade of 1990s		1980 to 2000	
	Output Growth	TFPG CONT	Output Growth	TFPG CONT	Output Growth	TFPG CONT
Cotton Textiles						
230: Cotton Ginning, Bailing & Cleaning	6.02	-36.96	9.67	18.06	7.94	-1.69
231: Cotton Spinning other than Mills	61.15	6.62	-21.52	12.93	17.64	2.57
232: W & F of Cotton- Khadi	6.19	-94.33	-6.63	23.44	-0.56	642.03
233: W & F of Cotton- Handloom	3.58	-4.65	1.92	-142.64	2.70	-56.15
234: W & F of Cotton- Powerloom	5.16	13.91	8.54	11.11	6.94	12.10
235: Cotton Spin/Weav/Proc in Mills	3.40	26.63	0.91	190.74	2.09	64.12
236: Printing of Cotton Textiles	8.07	5.87	12.45	-13.25	10.37	-6.20
Textile Products						
260: Knitted or Crocheted Textiles	11.73	6.00	13.71	-2.55	12.77	1.17
262: Threads, Cordage ,Ropes, Twines etc	-5.49	49.28	8.28	34.02	1.76	11.43
263: Blankets, Shawls, Carpets &Rugs	-0.40	980.97	16.03	53.84	8.25	32.68
265: Textile Garments & Accessories	13.56	10.40	14.75	-15.26	14.19	-3.65
267: Made-up Textiles	14.87	-88.78	28.83	-3.58	22.22	-30.60
268: Water Proof Textile Fabrics	1.06	-372.17	-2.95	-181.94	-1.05	-91.30
269: Textile Products, Nec	20.16	1.59	15.99	-5.85	17.97	-1.89
Leather Products						
290: Tanning, Curing, finishing of Leather	10.60	39.08	0.57	183.61	5.32	51.63
291: Leather Footwear	11.99	-0.41	10.91	5.11	11.42	-2.14
292: Apparel of Leather & Substitutes	23.69	-7.61	10.69	17.07	16.84	2.72
293:Leather products & Substitutes	23.00	9.21	19.55	-13.96	21.19	-1.61
299:Leather & Fur Products, Nec	5.85	-87.21	0.61	-828.96	3.09	-164.73
Chemicals & Chemical Products						
300:Organic & Inorganic Chemicals	4.14	67.30	8.07	12.07	6.21	29.50
301: Fertilizer & Pesticides	14.36	33.31	7.74	-5.72	10.88	18.69
302+306: Synthetic Rubber + Manmade Fibers	11.94	-82.24	17.67	37.27	14.96	-7.93
303: Paints, Varnishes & Products	4.11	-87.26	5.60	-51.38	4.89	-65.65
304: Drugs & Medicines	9.94	15.06	7.43	-43.02	8.62	-11.31
305: Perfumes, Cosmetics & lotions	22.86	6.48	5.82	-6.52	13.89	3.61
307: Safety Matches	6.25	36.52	10.45	20.16	8.46	25.89
308:Explosives & Fireworks	6.55	-25.41	4.05	-26.34	5.24	-25.79
309: Chemical Products, Nec	9.09	4.26	9.22	-16.26	9.16	-6.61
Rubber, Plastics, Petroleum etc						
310: Tyres & Tubes	9.52	8.59	8.57	2.78	9.02	5.68
311: Rubber & Plastic Footwear	11.89	-24.69	2.26	-12.93	6.82	-22.65
312: Rubber Products, Nec	8.45	7.18	7.74	-21.39	8.08	-7.23
313: Plastic Products, Nec	12.71	-4.96	12.98	5.78	12.85	0.75
314:Refined Petroleum Products	9.31	-64.59	2.44	78.38	5.69	-32.39
316:Refined Petroleum Products, Nec	7.40	-69.02	9.94	-33.93	8.74	-48.00
318:Coke-Oven Products	-0.27	-287.18	2.61	-35.87	1.25	-10.53
319:Other Coal/Tar products	10.75	79.31	-4.59	236.01	2.68	-61.95
Basic Metals & Alloys						
330: Iron & Steel in Primary/semi primary	5.83	21.54	-6.35	-21.01	-0.58	-224.08

331:Semi-finished Iron & Steel	2.01	-90.71	17.42	6.19	10.12	-2.94
332: Ferro-Alloys	6.20	-49.76	8.33	13.05	7.32	-12.15
333:Copper Manufacturing	4.91	-34.70	20.97	31.53	13.36	19.99
334:Brass Manufacturing	-4.25	87.58	10.87	-25.90	3.71	-87.40
335:Aluminium Manufacturing	10.59	28.77	5.48	-5.76	7.90	16.16
336: Zinc Manufacturing	3.72	-85.02	5.94	-12.50	4.89	-38.65
338+339:Metal Scraps & Non ferrous Metals	-0.68	97.11	-2.14	-176.61	-1.45	-115.69
Metal Products						
340: Fab Structural Metal Products	5.28	-75.81	4.64	-48.09	4.95	-62.12
341: Fab Structural Metal Products, Nec	2.42	-94.19	6.66	-31.96	4.65	-47.28
342: Furniture & Fixtures	-17.79	55.75	21.62	37.03	2.95	-16.43
343+349: Hand Tools, Weights Etc	1.78	-53.64	5.79	9.16	3.89	-4.41
344+345: Metal Products & Stamping/Forging	25.81	16.26	7.10	-32.94	15.96	4.74
346: Metal Kitchen Ware	-1.21	42.27	9.41	-20.96	4.38	-29.22
Machinery & Parts						
350: Agr Machinery, Equipment & Parts	5.52	18.00	8.64	1.59	7.17	7.58
351:Constr/Mining Machinery & Equipment	6.66	14.85	1.71	-134.88	4.06	-18.39
352: Prime Movers & Boilers	6.08	20.16	0.88	-49.12	3.35	10.52
353: Food & Textile Machinery	5.99	19.77	4.12	-45.39	5.00	-8.47
354: Other machinery	10.16	28.48	4.04	3.98	6.94	20.97
355: Refrigerators & Air conditioners	11.38	11.94	11.41	19.94	11.40	16.16
356:Gen Purpose Machinery	7.61	6.96	8.23	-2.42	7.93	1.84
357: Machine Tools, Parts & Accessories	5.53	29.73	0.11	775.91	2.68	46.36
358: Office & Computing Machines	13.31	33.95	14.46	14.12	13.92	23.10
359: Special Purpose Machinery	8.20	27.32	4.39	-5.16	6.20	15.20
Electrical Machinery & Parts						
360: Electrical Industrial Machinery	6.06	38.69	5.24	-33.59	5.63	3.29
361: Wires & Cables	3.93	1.30	8.42	0.29	6.29	0.59
362: Cells & Batteries	5.82	45.90	5.82	-15.86	5.82	13.39
363+364: Electrical Lamps, Fans & Domestic Appl	7.33	41.86	9.66	34.79	8.55	37.66
365+366: Radio & TV Apparatus	22.07	24.47	10.00	66.84	15.71	38.66
368: Electronic Valves &Tubes etc	21.01	23.84	17.32	12.35	19.07	18.35
369: X-Ray Machines & Electrical Equip, Nec	13.37	44.25	13.85	43.42	13.62	43.81
Transport Equipment & Parts						
370: Ships & Boats	-2.46	-4.02	11.83	10.80	5.06	14.21
371: Locomotives & Parts	-4.14	56.26	4.13	27.46	0.21	-238.39
372: Wagons & Coaches	4.22	99.58	-21.17	7.10	-9.14	-13.12
373+374: Motor Vehicles, Cars & Parts	9.00	12.65	11.54	-6.93	10.34	1.15
375: Motorcycles, Scooters & Products	17.98	8.72	9.13	-10.27	13.32	1.87
376: Bicycles and Parts	6.67	2.03	8.50	-2.32	7.63	-0.52
377: Aircraft & Related Products	10.05	3.83	6.98	37.83	8.43	18.64
379: Transport Equipment, Nec	11.04	1.31	3.18	33.94	6.90	9.21
All-Industries	**8.54**	**7.30**	**7.18**	**-0.18**	**7.82**	**-3.88**

Notes: All-Industries is a simple average of the 75 three digit industries
Source: Author's calculation based on the *Annual Survey of Industries.*

Magnitude and Direction of Productivity change

Table 3 presents the TFPG estimates for top-ten three-digit industries in each trade reform phase. We find that the combined value added shares of the top-ten industries are around 40 percent or more for each of the three phases of trade reforms. The following industry groups namely: iron and steel in primary form (330), cotton spinning in mills (235), organic & inorganic chemicals (300), primary plastics, synthetic rubber & manmade fibers (302+306), refined petroleum products (314), industrial electrical machinery (360), drugs and medicines (304) and motor vehicles (373+374) etc are the major contributors to value added for all the periods. Several industries within the top-ten value added contributors however record negative TFP growth rates. In the fourth phase of trade reforms, most industries record TFP growth rates above 1 percent per annum. Observing the period 1980-2000 in terms of the phases of trade reforms, we find that TFP growth rates have improved by the end of the 1990s, thereby indicating the lagged effect of productivity growth. This is consistent with the hypothesis that trade-reforms impact on productivity performance with a lag.

Chart 1 along with appendix Table A4 shows that for each phase, the maximum number of industries across the three-use based industry groups falls in the negative TFP growth range. Further, very few industries have TFP growth rates in excess of 5 percent under the different phases of trade reforms. For intermediate and capital goods industries, there is however an increase in the number of industries with TFP growth rates in excess of 5 percent per annum in the 1990s. For the all-industries group, more than 50 percent of the industries are below 1 percent TFP growth in each trade regime as evident from chart1. Comparing the 1980s with the 1990s, we observe that 62 and 48 percent of the industries recorded positive growth rates of TFP. For the period 1980-00, 41 industries recorded positive TFP growth accounting for around 39 percent gross value-added share.

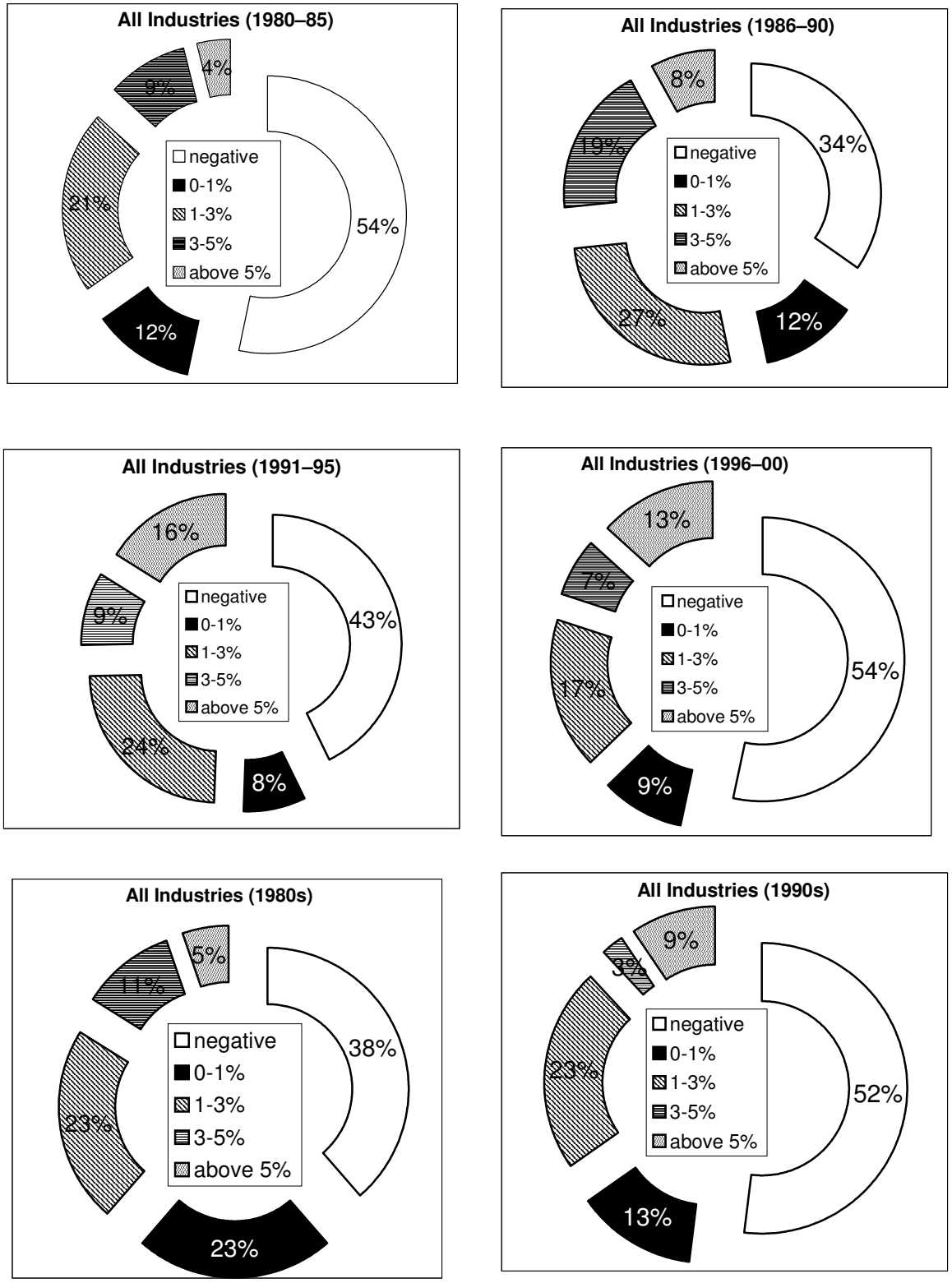
Table 3: TFPG and Output Growth under Trade Reform Phases: Top Ten Contributors to Value added

Phase-1 1980-85				Phase-2 1986-90				Phase-3 1991-95				Phase-4 1996-00			
Major Contributors To Value Added Top 10	VA[1] Share (%)	TFPG (%:pa)	Output Growth (%pa)	Major Contributors To Value Added Top 10	VA Share (%)	TFPG (%:pa)	Output Growth (%pa)	Major Contributors To Value Added Top 10	VA Share (%)	TFPG (%:pa)	Output Growth (%pa)	Major Contributors To Value Added Top 10	VA Share (%)	TFPG (%:pa)	Output Growth (%pa)
235	11.3	-1.92	0.38	330	8.8	2.44	9.71	330	9.4	0.53	4.06	330	7.22	1.60	-28.64
330	8.3	0.68	14.8	235	6.4	3.50	6.60	235	5.9	-0.71	5.10	302+306	5.15	-0.37	15.19
373+374	3.9	2.04	7.58	314	5.7	-5.25	7.42	373+374	4.4	4.84	11.11	301	5.06	1.14	11.78
300	3.5	1.16	8.46	373+374	4.4	0.46	10.33	314	4.0	-1.23	-3.26	373+374	4.88	1.14	5.26
360	3.5	0.00	1.75	300	3.6	3.85	2.23	360	3.5	-2.36	3.28	314	4.21	9.20	-2.24
301	3.4	3.62	11.14	304	3.0	2.79	11.84	301	3.4	-3.05	1.32	235	3.27	5.28	-3.52
331	3.2	-3.24	-1.46	331	2.87	-0.09	3.18	300	3.0	-3.48	4.30	304	3.24	1.50	2.50
304	3.0	-0.12	7.3	360	2.84	5.56	13.42	304	2.8	-0.35	6.41	360	2.81	2.64	2.49
314	1.6	-7.88	12.55	352	2.30	-1.45	-1.76	302+306	2.3	2.36	11.54	300	2.58	6.78	11.19
302+306	1.5	1.31	12.16	302+306	1.88	-7.88	0.54	365+366	1.7	2.07	14.63	335	2.55	-1.89	-2.88
Average[2]	43.2[3]	-0.43		Average	41. 8[3]	-0.39		Average	40.4 [3]	-0.13		Average	41.0[3]	2.70	

Notes: [1]VA shares for Phases 1, 2, 3 and 4 are for the years 1980-81, 1985-86, 1990-91 and 1995-96 respectively.
[2] Simple averages of the top ten industries
[3] Indicates the total Value-added share of top ten industries

Source: Author's calculation based on the *Annual Survey of Industries* and other data sources

Chart 1
Ranges of Average Annual TFP Growth under various Trade Reform Phases: All Industries



The appendix Tables A2 and A3 have attempted to classify the three-digit industries according to ranges of TFP growth rates and levels of protection, as captured by the effective rate of protection for the 1980s and 1990s. For the 1980s we observe that 43 industries with 54 percent share of total manufacturing value added record positive productivity growth. The majority of these industries numbering around 34 and a value added share of 40 percent however have protection level lower than the average ERP (118.53) for the industry. These industries are mainly from the capital goods sector and comprise the following two-digit sectors: namely non-electrical machinery (35), electrical machinery (36) and transport equipment (37). The following industries namely drugs and medicines (304), organic and inorganic chemicals (300), fertilizer and pesticides (301), chemical products (309), coke oven (318) and coal and tar products (319) and cotton textiles (231,234,235 and 236) comprise the rest. The industries with high protection as well as negative TFP growth comprise industries from the following two-digit categories: textile product (262, 267 and 268), leather and products (291,292,293, 299), basic chemicals (302+306, 303), rubber et al (311, 313), basic metals (331) and metal products (340, 341, 342 and 346).

In the 1990s exactly the same number of industries (47) had protection level less than the average ERP (93.52) for the industry. There was however a decline in the category of industries with TFP growth rates in the range of 0>TFPG > 2 and lower than average protection levels. Many more industries were situated in the −2< TFPG < 0 range as compared to the 1980s. Further, these primarily comprised the capital goods industries (351, 352,353, 356, 359, 360, 372 and 379) along with basic metals (335, 336), chemicals (301, 308, 309) and cotton textiles (232, 236). The industry groups with TFP growth rates higher than 2 percent in the 1990s numbering around 15 contributed around 5 percent of total manufacturing value-added share. Further 10 industries had lower than average protection levels.

Use-based Industry Groups

The use-based classification of manufacturing into capital goods, intermediate goods and consumer goods allows us to trace the performance of these industries in line with the

focus of trade policies within the overall industrialization strategy. Accordingly we have split the 75 three-digit industries into intermediate goods (30), capital goods (20) and consumer goods (25). The TFP growth rates are documented in Table 4 according to the use-based industry groups for the four phases of trade reforms. A large number of industries are situated in the range of zero or negligible growth rates across the use-based sectors and the trade reform phases. Observing the TFP growth rates, we find that there are wide fluctuations across the industries as well as the phases of trade reforms for each of the use-based sectors.

Many industries belonging to the three use-based categories record negative TFP growth in each of the trade reform phases. For the intermediate goods sector 22, 12, 14 and 17 industries contributing around 24, 12, 22 and 15 percent of total manufacturing value added record negative TFP growth rate. For the capital goods sector, the number of industries recording negative TFP growth is the largest in the fourth phase of trade reforms. The consumer goods sector shows a large concentration of industries in the range of 1 to < 5 percent TFP growth.

In case of the intermediate goods sectors, we observe very few industries above 2 percent rate of growth of TFP in each phase. Tanning and curing of leather (290) records the maximum TFP growth (6.57 percent) in the period 1980-85. In the second phase of trade reform, we observe 11 industries above TFP growth rate of 2 percent per annum. In the period of 1990s captured in two phases of trade reforms 1991-95 and 1996-00, we find marginal decline in the number of industries with TFP growth in excess of 2 percent. Cotton spinning in mills (235), threads, ropes and cordage (262), organic and inorganic chemicals (300), plastic products (313) and copper manufacturing (333) are however some of the industries which record TFP growth rates in excess of 5 percent. The average TFP growth for the intermediate goods sector remained either zero or negative for all the four phases of trade reforms.

Table 4: Average Annual TFP Growth Rates under Phases of Trade Reforms: Use-Based Industry Groups

NIC-87	INDUSTRY DESCRIPTION	PHASE-1 1980-85		PHASE-2 1986-90		PHASE-3 1991-95		PHASE-4 1996-00	
Code	Three-digit industries	VA share	TFPG	VA share	TFPG	VA share	TFPG	VA share	TFPG
230	Cotton Ginning, Bailing & Cleaning	0.35	-0.61	0.37	-2.64	0.28	1.17	0.33	1.96
231	Cotton Spinning other than Mills	0.00	-5.97	0.00	5.17	0.02	6.72	0.01	-5.25
235	Cotton Spinning/Weaving/Processing in Mills	11.27	1.92	6.36	3.50	5.87	-0.71	3.27	5.28
262	Threads, Cordage, Ropes, Twines	0.06	-4.57	0.31	-0.21	0.41	1.07	0.23	5.59
290	Tanning, Curing, Finishing of Leather	0.36	6.57	0.04	-0.48	0.03	9.28	0.03	-6.16
300	Organic & Inorganic Chemicals	3.54	1.16	3.01	3.85	3.03	-3.48	2.58	6.78
301	Fertilizer & Pesticides	3.46	3.62	3.70	6.24	3.44	-3.05	5.06	1.14
302+306	Sythc Rubber & Manmade Fibre	1.50	-1.31	1.88	-7.88	2.29	2.36	5.15	-0.37
303	Paints, Varnishes & Products	1.18	-7.99	0.84	1.33	1.10	-0.03	1.04	-6.90
308	Explosives & Fireworks	0.22	-1.71	0.25	0.83	0.19	0.53	0.19	-7.15
309	Chemical Products, Nec	0.92	-1.01	0.80	1.97	0.81	3.35	1.02	-4.47
310	Tyres & Tubes	1.12	-1.00	1.58	2.48	1.30	-0.43	1.09	1.53
312	Rubber Products, Nec	0.54	-0.75	0.50	1.73	0.44	0.60	0.40	-2.06
313	Plastic Products, Nec	0.72	-4.28	1.03	3.79	1.25	2.12	1.19	5.78
314	Refined Petroleum Products	1.60	-7.88	5.57	-5.25	4.02	2.23	4.21	9.2
316	Refined Petroleum Products, Nec	0.40	-8.84	0.21	-4.15	0.23	4.13	0.22	-2.07
318	Coke-Oven Products	0.51	-4.73	0.14	6.95	0.18	1.56	0.23	1.22
319	Other Coal/Tar Products	0.17	-3.33	0.11	1.06	0.16	-4.09	0.18	-10.18
330	Iron & Steel in Primary/Semi primary	8.29	0.68	8.81	2.44	9.40	-3.12	7.22	1.60
331	Semi-finished Iron & Steel	3.22	-3.24	2.87	-0.09	1.34	2.38	1.56	-1.44
332	Ferro-Alloys	0.29	-4.25	0.27	-2.36	0.22	-0.86	0.37	4.57
333	Copper Manufacturing	0.21	0.09	0.11	-2.65	0.23	1.28	0.12	15.15
334	Brass Manufacturing	0.16	-1.53	0.12	-4.63	0.07	-0.27	0.07	-10.35
335	Aluminum Manufacturing	0.43	2.05	0.48	2.08	1.19	8.62	2.55	-1.89
336	Zinc Manufacturing	0.21	-6.59	0.10	-0.88	0.18	-2.2	0.12	-4.80
338+339	Metal Scraps & Non Ferrous Metals	0.09	-1.31	0.09	0.17	0.09	1.26	0.02	7.42
340	Fab Structural Metal Products	0.37	-11.04	0.38	4.49	0.44	-4.00	0.33	-1.29
341	Fab Structural Metal Products, Nec	0.79	-8.69	0.71	3.87	0.52	-4.58	0.49	-0.53
343+349	Handtools,Weights Etc	0.18	-0.30	0.78	-2.42	0.70	0.23	0.43	-0.39
344+345	Metal Produtcs & Stamping/Forging of Metals	0.06	4.73	0.08	1.25	0.41	-2.43	1.10	-2.81

	Intermediate goods sector								
	Mean[1]	**42.22[5]**	**-1.26**	**41.50**	**1.17**	**39.84**	**-0.39**	**40.81**	**1.76**
	Standard Deviation[2]		3.23		3.82		2.19		4.12
	Coefficient of Variation[3]		-256		327		-561		233
	Correlation Coefficient[4]		0.04		-0.34		-0.43		0.05
350	Agr Machinery, Equipment & Parts	0.82	1.11	0.80	1.76	0.88	1.41	0.78	-2.78
351	Const /Mining Machines & Equipment	0.68	-1.13	0.52	1.25	0.37	-1.16	0.28	-2.24
352	Prime Movers & Boilers	1.32	2.71	2.30	-1.45	0.95	0.51	1.13	-0.54
353	Food & Textile Machinery	1.39	-1.76	0.93	4.04	0.91	2.20	0.97	-7.61
354	Other Machinery	0.43	2.81	0.41	0.99	0.69	-0.54	0.33	2.84
356	General Purpose Machinery	1.48	0.66	1.52	0.84	1.55	1.76	1.54	-3.37
357	Machine tools, Parts & Accessories	0.86	4.66	1.10	-1.75	0.60	2.38	0.61	-0.71
358	Office & Computing Machines	0.13	3.78	0.16	4.04	0.08	2.01	0.05	2.99
359	Special Purpose Machinery	0.34	2.66	0.36	0.95	0.32	6.08	0.63	-7.63
360	Electrical Industrial Machinery	3.51	0.00	2.84	5.56	3.48	-2.36	2.81	-3.13
361	Wires & Cables	1.26	-1.49	0.67	1.33	0.95	-1.81	0.97	2.64
362	Cells & Batteries	0.46	0.44	0.38	2.69	0.35	7.85	0.57	-10.01
365+366	Radio & TV Apparatus	0.98	5.49	1.54	3.31	1.75	2.07	1.54	15.28
368	Electronic Valves &Tubes etc	0.13	2.30	0.17	5.76	0.27	3.98	0.41	1.56
369	X-ray Mach & Electrical Equipment Nec	0.15	3.14	0.15	5.62	0.15	6.94	0.22	8.71
370	Ships & Boats	0.82	-2.78	0.23	2.36	0.15	3.57	0.22	-0.53
371	Locomotives & Parts	1.16	-7.80	0.19	-0.32	0.21	-0.43	0.18	8.29
372	Wagons & Coaches	1.36	2.94	1.33	4.98	1.10	-0.68	0.60	-3.36
377	Aircraft & Related Products	0.19	1.13	0.16	0.87	0.13	7.27	0.26	-4.12
379	Transport Equipment NEC	0.13	-2.02	0.07	2.05	0.15	5.27	0.16	-3.61
	Capital goods sector								
	Mean[1]	**17.60[5]**	**0.34**	**15.83**	**2.23**	**15.04**	**0.62**	**14.26**	**-0.51**
	Standard Deviation[2]		3.06		2.59		2.56		6.50
	Coefficient of Variation[3]		904		116		416		-1270
	Correlation Coefficient[4]		0.16		0.09		-0.23		0.13
232	W& F of Cotton Khadi	0.01	6.63	0.03	-13.91	0.01	-13.51	0.01	-5.84
233	W & F of Cotton- Handloom	0.05	3.94	0.04	-5.82	0.02	0.47	0.03	-0.17
234	W & F of Cotton- Powerloom	0.10	3.12	0.10	-3.46	0.08	7.65	0.15	0.72

236	Printing of Cotton Textiles	0.39	0.58	0.41	-0.17	0.33	-0.76	0.23	0.47
260	Knitted or Crochted Textiles	0.18	-0.70	0.24	2.38	0.35	-0.91	0.49	0.70
263	Blankets, Shawls, Carpets &Rugs	0.10	-2.20	0.06	-0.17	0.09	-1.14	0.05	-3.90
265	Textile Garments & Accessories	0.41	-1.48	0.45	2.91	1.04	-1.89	1.79	1.41
267	Made-Up Textiles	0.01	-29.80	0.01	4.49	0.01	1.53	0.04	-13.21
268	Water Proof Textile Fabrics	0.09	-9.71	0.05	4.63	0.05	-1.60	0.05	-3.93
269	Textile Products, Nec	0.03	0.00	0.02	-2.22	0.03	-0.01	0.05	0.32
291	Leather Footwear	0.26	1.42	0.30	-2.16	0.40	2.18	0.31	-0.05
292	Apparel of Leather & Substitutes	0.01	-5.90	0.02	1.50	0.08	6.69	0.08	-1.80
293	Leather Products & Substitutes	0.00	0.05	0.01	2.27	0.04	7.09	0.12	2.12
299	Leather & Fur Products, Nec	0.00	-10.22	0.00	-0.06	0.01	-7.41	0.01	-5.10
304	Drugs & Medicines	3.00	-0.12	3.03	2.79	2.79	-0.35	3.24	1.50
305	Perfumes, Cosmetics & lotions	0.67	-1.31	0.60	4.57	1.12	-1.59	0.87	1.48
307	Safety Matches	0.24	2.40	0.21	1.96	0.10	6.67	0.11	2.28
311	Rubber and Plastic Footwear	0.14	-0.78	0.12	0.06	0.56	-5.11	0.12	-0.06
342	Furniture & Fixtures	0.34	0.08	0.30	-17.44	0.03	11.91	0.04	-9.92
346	Metal Kitchen Ware	0.31	2.22	0.23	-4.00	0.15	-3.55	0.16	-0.51
355	Refrigerators & Air conditioners	0.77	1.90	0.75	-0.64	0.09	1.23	0.33	1.36
363+364	Electric Lamps, & Domestic Appliances	0.66	2.93	0.65	2.90	0.59	3.54	0.45	3.07
373+374	Motor vehicles, Cars & Relative Prods	3.93	2.04	4.38	0.46	4.35	4.84	4.88	1.14
375	Motor cycles, Scooters & Products	0.52	-0.08	0.85	3.83	1.28	1.92	1.50	1.57
376	Bicycles and Parts	0.29	-1.63	0.26	3.42	0.40	0.44	0.31	0.14
	Consumer goods sector								
	Mean[1]	**12.51[5]**	**0.79**	**13.12**	**1.03**	**14.0**	**1.43**	**15.42**	**-5.06**
	Standard Deviation[2]		1.88		3.46		3.02		4.29
	Coefficient of Variation[3]		239		337		211		-85
	Correlation Coefficient[4]		-0.39		0.02		0.10		0.66

Note: 1. indicates the value added share weighted average of the sector
2. indicates the standard deviation
3. coefficient of variation
4. correlation coefficient between phases 1&2, 2&3, 3&4 and 4&1
5. total value added share of the respective industries within a use-based sector

Source: Authors calculation based on the *Annual Survey of Industries* and other data sources

The capital goods sector comprises 3-digit industries from the following two-digit sectors, namely non-electrical machinery and parts (35), electrical machinery (36) and transport equipment (37). This sector accounts for around 18 percent of manufacturing value added and records TFP growth an average TFP growth of more than 2 percent in the second and third periods of trade reforms. Two industry groups namely electronic valve and tubes (386) and x-ray machines and other electronic equipment (369) record TFP growth rates above the average consistently for each of the periods of trade reforms.

The 25 industries listed under the consumer goods industries account for around 12-15 percent of the total manufacturing value added for the phases of trade reforms. More than half the industries record TFP growth rates in the ranges of either zero or negligible (0 <TFPG< 1%) in each of the four phases of trade reforms. The number of industries with TFP growth rates in excess of 2 percent per annum is the highest for the second phase of trade reforms. The average TFP growth rate for each of the four phases of trade reforms is negligible or negative. For the period 1980-2000, we observe only four industry groups namely, blankets et.al. (263), safety matches (307), electrical lamps et al (363+364) and motor vehicles et al (373+374) to record TFP growth rates in the range of 2-6 percent per annum.

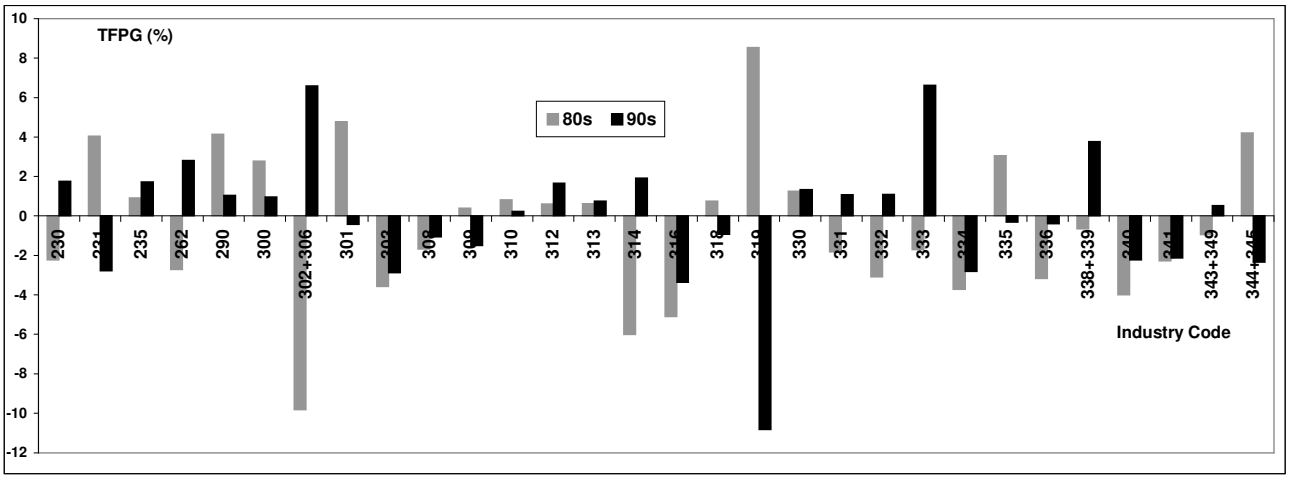
Chart 2 presents the comparative productivity growth profile for the use-based sectors in the 1980s and 1990s. Observing the intermediate goods sector, we find that for some industries [cotton weaving (230), threads et al (262), synthetic and manmade fibers (3032+306), refined petroleum products (314), iron and steel (331), ferro-alloys (332), copper manufacturing (333), metal scraps et al (338+339)] there is a switch from negative TFP growth to large positive growth rates in the 1990s. There is however no change in the average TFP growth rate for this sector in the 1990s when compared to the 1980s. For capital goods sector, we find that only for one industry group [locomotives and parts (371)], there is a change from negative to positive TFP growth rates. The average TFP growth rates for the capital goods sector declines in the 1990s from a growth rate of over 2 percent in the 1980s. For consumer goods industries we however find three industry groups namely blankets et al (263), water proof textiles (268) and furniture and fixtures

of metals (342) recording large jumps in TFP growth rates between 1980s and 1990s. In the case of the consumer goods industries, we find that there is a marginal improvement in the average TFP growth rate for the 1990s as compared to the 1980s.

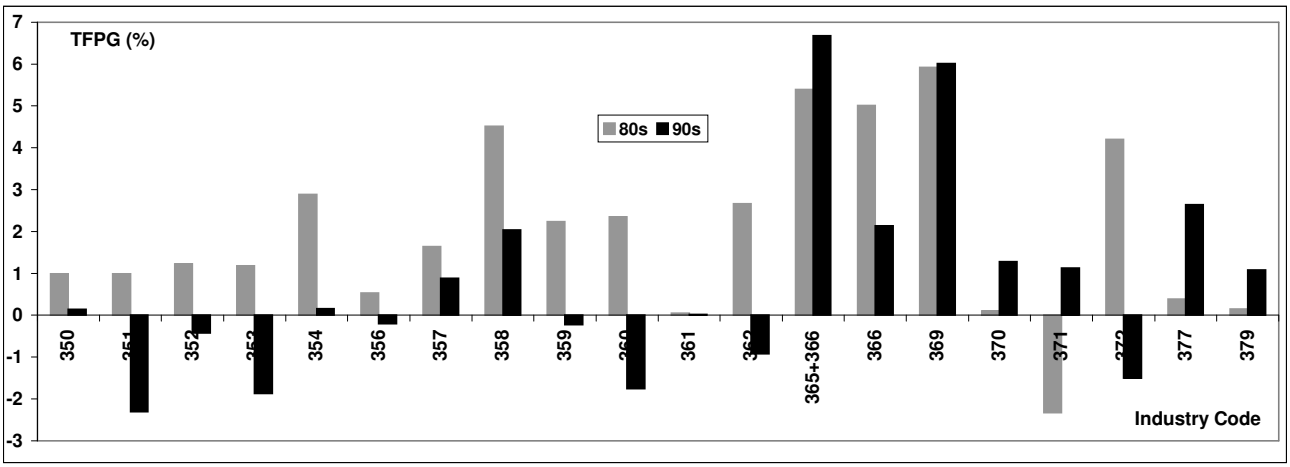
Comparing the three use based sectors, we find that only for four industry groups, there is further improvement in the 1990s from an already positive TFP growth scenario in the 1980s [radio and TV apparatus (365+366), x-ray machines and other equipment (369), refrigerators and air-conditioners (355) and electrical lamps et al (363+364)].

Chart 2
TFP Growth in 1980s and 1990s: Use-based Industries

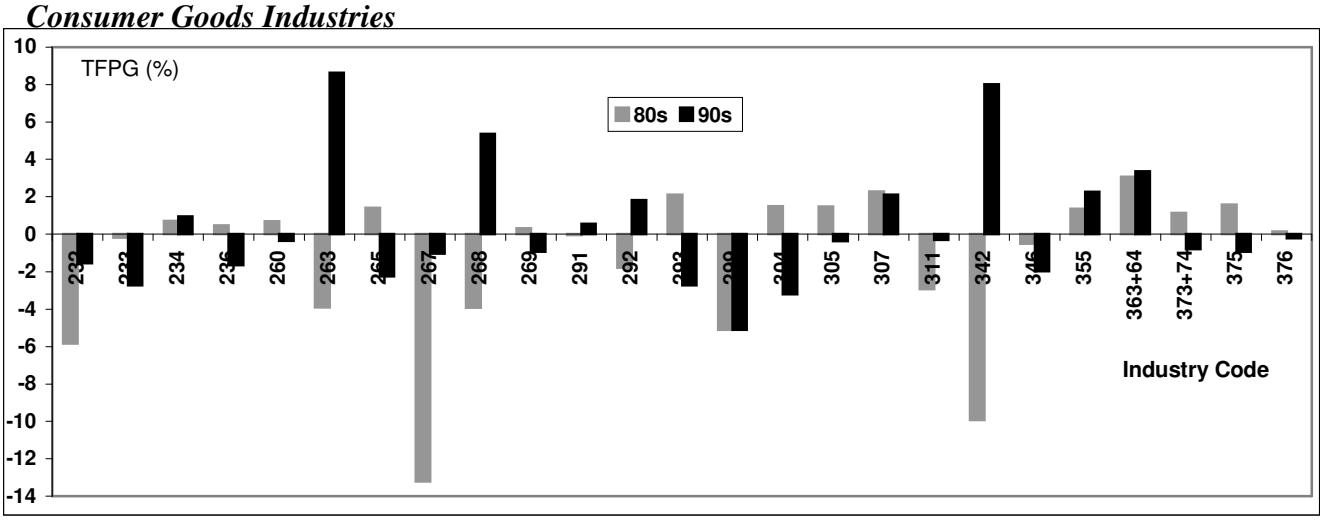
Intermediate Good Industries



Capital Goods Industries



Consumer Goods Industries



5. Conclusion

Using data from the Annual Survey of Industries, total factor productivity growth rates have been computed for the period from 1980-81 to 1999-00 and for the four sub-periods corresponding to the 4 phases of trade reforms. Our results at the three-digit level of disaggregation indicate TFP growth of 0.08 percent per annum averaged over 75 three-digit industries for the entire period. The standard deviation and coefficient of variation both show considerable variations in TFP growth. The TFP growth rates for individual industries are either negative or in the 0 to 2 percent range. The capital goods sector is the only one to register a positive growth (1.39 percent per annum) throughout the period, the intermediate and consumer goods sectors both record negative growth in TFP during the entire period. The performance of the capital goods sector suggests that easing of quantitative restrictions on imports of machinery and spare parts has introduced external competition in the capital goods industries resulting in an improvement in productivity growth.

Comparison across the phases of trade reform shows that in all the three use-based sectors, TFP growth performance is best either in the third phase (1991-95) [capital as well as consumer goods sector] or the second phase (1986-90) [intermediate goods sector]. The second phase of trade liberalization coincided with the announcement of a three-year import-export policy complementing some of the industrial policy reforms. An increasing number of capital goods and intermediates and raw materials were added to the open general licensing lists. Replacement of quantitative restrictions by tariffs however led to an increase in the tariff rates. Further, the period was also marked by unsustainable fiscal expansion leading to demand and capacity utilization and resultantly productivity growth. The TFP growth in the 1990s is found to be lower than in the 1980s. In addition, for all three use-based sectors, the TFP growth in the second half of the 1990s (1996-00) is lower than the first half of the 1990s (1991-95).

Our results indicate that productivity performance seemed to worsen as the pace of trade reform gathered momentum. This is evident from the TFP growth recorded by

the industries in successive phases of trade reform. The experience of the eighties on the productivity front seemed to have provided assurance of the potential that existed from reforms in trade and industrial policy. Our result suggests that this was misplaced. We observe that there is a marked fall in the growth rate of TFP in Indian manufacturing in the 1990s as compared to the 1980s. Further this is corroborated by several studies covering the period of 1990s [Trivedi et al. (2000), Srivastava (2000), Balakrishnan et al 2000), Goldar (2000) and Banga (2003)].

The worsening of TFP growth rate in the 1990s for a vast majority of industries seems perplexing, as this was the phase when substantial and far-reaching trade reforms encompassing the lowering of both tariff and non-tariff barriers were initiated. Two possible explanations for the slow down in TFP growth may be offered. First industrial production in the years 1990-91 and 1991-92 was constrained by factors like import compression, tight-money policy, inflationary pressures and fiscal contraction initiated by the government as part of the macroeconomic stabilization programs. These led to a recessionary trend in the manufacturing sector. Second, Mergers began to pick up only towards the end of the 1995 and constraints operate in the functioning of the labor markets, particularly the exit policies that ought to supplement the trade liberalization attempts. In addition, it should be noted that available evidence from various countries shows that the beneficial impact of trade liberalization on productivity can take considerable time to show up after structural adjustment and industrial restructuring has taken place. This needs to be explored in future research.

Appendix

Table A1: Sample Industries and Value added Shares: Three-digit Industrial Classification

Code NIC87	Three-Digit Industries Description	1980-81	1985-86	1990-91	1995-96
23	**Cotton Textile**	**16.83**	**10.31**	**9.54**	**4.03**
230	Cotton Ginning, Bailing & Cleaning	0.35	0.37	0.28	0.33
231	Cotton Spinning other than Mills	0.00	0.00	0.02	0.01
232	W& F of Cotton Khadi	0.01	0.03	0.01	0.01
233	W & F of Cotton- Handloom	0.05	0.04	0.02	0.03
234	W & F of Cotton- Powerloom	0.10	0.10	0.08	0.15
235	Cotton Spin/Weav/Proc in Mills	11.27	6.36	5.87	3.27
236	Printing of Cotton Textiles	0.39	0.41	0.33	0.23
26	**Textile Products**	**1.21**	**1.20**	**2.31**	**2.48**
260	Knitted or Crochted Textiles	0.18	0.24	0.35	0.49
262	Threads, Cordage,Ropes,Twines etc	0.06	0.04	0.03	0.03
263	Blankets, Shawls, Carpets &Rugs	0.10	0.06	0.09	0.05
265	Textile Garments & Accessories	0.41	0.45	1.04	1.79
267	Made-Up Textiles	0.01	0.01	0.01	0.04
268	Water Proof Textile Fabrics	0.09	0.05	0.05	0.05
269	Textile Products, Nec	0.03	0.02	0.03	0.05
29	**Leather and Leather Products**	**0.89**	**0.90**	**1.37**	**0.75**
290	Tanning, Curing, Finishing of Leather	0.36	0.31	0.41	0.23
291	Leather Footwear	0.26	0.30	0.40	0.31
292	Apparel of Leather & Substitutes	0.01	0.02	0.08	0.08
293	Leather Products & Substitutes	0.00	0.01	0.04	0.12
299	Leather & Fur Products, Nec	0.00	0.00	0.01	0.01
30	**Chemicals and Chemical Products**	**20.37**	**20.98**	**21.40**	**19.26**
300	Organic & Inorganic Chemicals	3.54	3.61	3.03	2.58
301	Fertlizer & Pesticides	3.46	3.70	3.44	5.06
302+306	SyntheticRubber & Manmade Fibre	1.50	1.88	2.29	5.15
303	Paints, Varnishes & Products	1.18	0.84	1.10	1.04
304	Drugs & Medicines	3.00	3.03	2.79	3.24
305	Perfumes, Cosmetics & Lotions	0.67	0.60	1.12	0.87
307	Safety Matches	0.24	0.21	0.10	0.11
308	Explosives & Fireworks	0.22	0.25	0.19	0.19
309	Chemical Products, Nec	0.92	0.80	0.81	1.02
31	**Rubber,Plastics,Petroleum etc**	**7.18**	**13.05**	**11.72**	**7.64**
310	Tyres & Tubes	1.12	1.58	1.30	1.09
311	Rubber & Plastic Footwear	0.14	0.12	0.56	0.12
312	Rubber Products, Nec	0.54	0.50	0.44	0.40
313	Plastic Products, Nec	0.72	1.03	1.25	1.19
314	Refined Petroleum Products	1.60	5.57	4.02	4.21
316	Refined Petroleum Products, Nec	0.40	0.21	0.23	0.22
318	Coke-Oven Products	0.51	0.14	0.18	0.23
319	Other Coal/Tar Products	0.17	0.11	0.16	0.18

33	**Basic Metals and Alloys**	**17.84**	**18.08**	**18.32**	**12.03**
330	Iron & Steel in Primary/Semiprimary	8.29	8.81	9.40	7.22
331	Semi-finished Iron & Steel	3.22	2.87	1.34	1.56
332	Ferro-Alloys	0.29	0.27	0.22	0.37
333	Copper Manufacturing	0.21	0.11	0.23	0.12
334	Brass Manufacturing	0.16	0.12	0.07	0.07
335	Aluminium Manufacturing	0.43	0.48	1.19	2.55
336	Zinc Manufacturing	0.21	0.10	0.18	0.12
338+339	Metal Scraps & Non Ferrous Metals	0.09	0.09	0.09	0.02
34	**Metal Products**	**2.85**	**3.49**	**3.25**	**2.53**
340	Fab Structural Metal Products	0.37	0.38	0.44	0.33
341	Fab Structural Metal Products, Nec	0.79	0.71	0.52	0.49
342	Furniture & Fixtures	0.34	0.30	0.03	0.04
343+349	HandTools, Weights ,Etc	0.18	0.78	0.70	0.43
344+345	Metal Prods & Stamping/Forging of metals	0.06	0.08	0.41	1.10
346	Metal Kitchen Ware	0.31	0.23	0.15	0.16
35	**NonElectrical Machinery and Parts**	**11.35**	**12.46**	**10.02**	**6.95**
350	Agr Machinery, Equipments & Parts	0.82	0.80	0.88	0.78
351	Constr/Mining Machines & Equipment	0.68	0.52	0.37	0.28
352	Prime Movers & Boilers	1.32	2.30	0.95	1.13
353	Food & Textile Machinery	1.39	0.93	0.91	0.97
355	Refrigerators & Air conditioners	0.77	0.75	0.69	0.33
354	Other machinery	0.43	0.41	0.61	0.62
356	General Purpose Machinery	1.48	1.52	1.55	1.54
357	Machine Tools, Parts & Accessories	0.86	1.10	0.60	0.61
358	Office & Computing Machines	0.13	0.16	0.08	0.05
359	Special Purpose Machinery	0.34	0.36	0.32	0.63
36	**Electrical Machinery and Parts**	**9.88**	**9.00**	**10.87**	**6.97**
360	Electrical Industrial Machinery	3.51	2.84	3.48	2.81
361	Wires & Cables	1.26	0.67	0.95	0.97
362	Cells & Batteries	0.46	0.38	0.35	0.57
363+364	Electric Lamps, Fans & Domestic Appliances	0.66	0.65	0.59	0.45
365+366	Radio & TV Apparatus	0.98	1.54	1.75	1.54
368	Electronic Valves &Tubes etc	0.13	0.17	0.27	0.41
369	X-Ray Machines & Electrical Equipment ,Nec	0.15	0.15	0.15	0.22
37	**Transport Equipment and Parts**	**11.61**	**10.53**	**11.20**	**8.10**
370	Ships & Boats	0.82	0.23	0.15	0.22
371	Locomotives & Parts	1.16	0.19	0.21	0.18
372	Wagons & Coaches	1.36	1.33	1.10	0.60
373+374	Motor Vehicles, Cars & Products	3.93	4.38	4.35	4.88
375	Motorcycle, Scooter & Products	0.52	0.85	1.28	1.50
376	Bicycles & Parts	0.29	0.26	0.40	0.31
377	Aircraft & Related Products	0.19	0.16	0.13	0.26
379	Transport Equipment, Nec	0.13	0.07	0.15	0.16
	All- Industries	**72.33**	**71.05**	**69.51**	**70.75**

Notes: 1.Value-added share represents share in total manufacturing gross value added
2.Sectors share is computed as the sum of individual industries share in sample manufacturing gross value-added
Source: Author's calculation based on the *Annual Survey of Industries*

Table A2: Distribution of 3 digit industries by TFP growth and Protection level: The decade of 1980s

Protection	TFPG< -2.00	-2.00<TFPG<0.00	0.00<TFPG<2.00	TFPG >2.00	Total
Protection Level Higher than AVG ERP (> 118.53)	262 (0.03) 267 (0.02) 268 (0.06) 293 (0.04) 299 (0.01) 302+306 (2.29) 303 (1.10) 311 (0.57) 340 (0.44) 341 (0.53) 342 (0.04) **(11)5.13**	291 (0,41) 292 (0.08) (1.25) 331 (1.35) 346 (0.15) **(5) 3.24**	260 (0.35) 265 (1.04) 269 (0.03) 305 (1.12) 310 (1.30) 312 (0.44) 330 (9.40) **(7) 13.68**	290 (0.41) 362 (0.35) **(2) 0.76**	**(25) 22.81**
Protection Level Lower than AVG ERP (<118.53)	230 (0.28) 232 (0.01) 263 (0.09) 314 (4.02) 316 (0.23) 332 (0.22) 336 (0.18) 371 (0.21) **(8) 5.24**	233 (0.02) 308 (0.19) 333 (0.23) 338+339 (0.09) 343+349 (0.70) **(5) 1.23**	234 (0.09) 235 (5.87) 236 (0.33) 304 (2.79) 309 (0.82) 318 (0.18) 350 (0.88) 351 (0.37) 352 (0.95) 353 (0.91) 355 (0.61) 356 (1.55) 357 (0.60) 361 (0.96) 370 (0.16) 373+374 (4.35) 375 (1.28) 376 (0.40) 377 (0.30) 379 (0.15) **(20) 23.55**	231 (0.02) 300 (3.03) 301 (3.44) 319 (0.10) 335 (1.19) 354 (0.69) 358 (0.08) 359 (0.32) 360 (3.48) 363+364 (0.59) 365+366 (1.75) 368 (0.28) 369 (0.15) 372 (1.10) **(14) 16.22**	**(47) 46.24**
Total	**(19) 10.37**	**(10) 4.47**	**(27) 37.23**	**(16) 16.98**	**(72) 69.05**

Note: The average ERP is computed from industry-wise ERPs for the period 1980-81 to 1989-90, See Das (2002b)
Source: Authors Calculations

Table A3: Distribution of 3 digit industries by TFP growth and Protection level: The decade of 1990s

Protection	TFPG< -2.00	-2.00<TFPG<0.00	0.00<TFPG<2.00	TFPG >2.00	Total
Protection Level Higher than AVG ERP (>93.52)	265 (0.41) 303 (1.18) 340 (0.37) 341 (0.79) **(4) 2.75**	260 (0.18) 267 (0.01) 269 (0.03) 291 (0.26) 305 (0.07) 311 (0.14) 312 (0.54) 346 (0.31) 362 (0.46) 373+374 (3.93) 375 (0.52) **(11) 6.45**	300 (3.54) 310 (1.12) 313 (0.72) 330 (8.29) 331 (3.22) **(5) 16.89**	262 (0.06) 268 (0.09) 302+306 (1.50) 342 (0.34) 377 (0.19) **(5) 2.18**	**(25) 28.27**
Protection Level Lower than AVG ERP (<93.52)	231 (0.00) 233 (0.05) 293 (0.00) 299 (0.00) 304 (3.00) 316 (0.40) 319 (0.17) **(7) 3.62**	232 (0.01) 236 (0.39) 301 (3.46) 308 (0.22) 309 (0.92) 318 (0.51) 335 (0.43) 336 (0.21) 351 (0.08) 352 (1.32) 353 (1.39) 356 (1.48) 359 (0.34) 360 (3.51) 372 (1.36) 376 (0.29) (16) 17.51	230 (0.35) 234 (0.10) 235 (11.27) 290 (0.36) 314 (1.60) 332 (0.29) 343+349 (0.18) 350 (0.82) 354 (0.77) 357 (0.80) 361 (1.20) 370 (0.82) 371 (1.16) 379 (0.13) **(14) 19.49**	263 (0.10) 292 (0.01) 333 (0.21) 338+339 (0.09) 355 (0.43) 358 (0.13) 363+364 (0.66) 365+366 (0.98) 368 (0.13) 369 (0.15) **(10) 2.89**	**(47) 43.51**
Total	**(11) 6.37**	**(27) 23.96**	**(19) 36.38**	**(15) 5.07**	**(72) 71.78**

Note: The average ERP is computed from industry-wise ERPs for the period 1990-91 to 1994-95, See Das (2002b)
Source: Authors Calculations

Table A4: Distribution of Use-Based Industries by TFPG under Trade Reform Phases

TFP Growth	Intermediate Goods		Capital Goods		Consumer Goods		All- Industries	
			Phase-1: 1980-85					
TFPG Range	N	VAS	N	VAS	N	VAS	N	VAS
Negative	22	24.36	6	5.43	12	5.42	40	35.21
0- 1 percent	2	8.50	3	5.45	4	0.77	9	14.72
1-3 percent	3	5.48	7	4.93	6	5.84	16	16.25
3-5 percent	2	3.53	3	1.13	2	0.15	7	4.81
Above 5 percent	1	0.36	1	0.98	1	0.01	3	1.35
Total	30	42.2	20	17.9	25	12.1	75	72.33
			Phase-2: 1986-90					
TFPG Range	N	VAS	N	VAS	N	VAS	N	VAS
Negative	12	12.63	3	3.60	11	1.86	26	18.09
0- 1 percent	2	0.34	4	2.79	3	4.53	9	7.66
1-3 percent	8	13.2	6	2.66	6	4.58	20	20.44
3-5 percent	5	12.09	4	3.97	5	1.77	14	17.83
Above 5 percent	3	3.84	3	3.16	0	0.00	6	7.00
Total	30	42.11	20	16.18	25	12.77	75	71.05
			Phase-3: 1991-95					
TFPG Range	N	VAS	N	VAS	N	VAS	N	VAS
Negative	14	22.45	6	6.81	12	6.53	32	35.79
0- 1 percent	3	10.45	1	0.91	2	0.42	6	11.78
1-3 percent	8	4.8	6	4.60	4	2.31	18	11.71
3-5 percent	3	1.62	2	0.43	2	6.10	7	8.15
Above 5 percent	2	0.43	5	1.10	5	0.35	12	1.88
Total	30	39.75	20	13.85	25	15.71	75	69.31
			Phase-4: 1996-00					
TFPG Range	N	VAS	N	VAS	N	VAS	N	VAS
Negative	17	15.08	13	10.55	11	0.88	40	26.51
0- 1 percent	1	1.09	0	0	6	1.56	7	2.65
1-3 percent	4	12.83	1	2.05	7	12.51	13	27.39
3-5 percent	1	0.37	3	0	1	0.45	5	0.82
Above 5 percent	7	11.42	3	1.94	0	0.00	10	13.36
Total	30	40.80	20	14.55	25	15.40	75	70.75

Notes: 1. For each 3-digit industry group, TFP growth is the average of the year to year annual rates of growth over the specified period.
2. VAS stands for share of the 3-digit industry in total manufacturing gross value-added
3. N stands for the number of 3-digit industry groups in each category

Sources: Authors calculation based on the *Annual Survey of Industries* and other data sources

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