TRADE AND PRODUCTIVITY IN INIDIAN ORGANISED MANUFACTURING: AN INDUSTRY LEVEL ANALYSIS≠

ABSTRACT

The paper examines the impact of international trade on the productivity growth of organised manufacturing sector in India during 1980-2007. We argue that trade can affect domestic manufacturing productivity growth through competition effects, economies of scale effects, reallocation effects and spillover effects. We examine these trade-productivity linkages by considering trade related variables such as relative import prices, import penetration and export orientation on the productivity of the Indian manufacturing sector. The estimates of 62 four-digit balanced panel industries using random effect method revealed that trade have considerable impact on productivity growth. We found that trade induced channels such as reallocation and economies of scale effects operate mainly through imports. On the other hand, the effect of export intensity on productivity is weak and not robust across industry disaggregation. We further observed that the impact of international trade on productivity growth is not static but dynamic in nature.

JEL Classification: **F14, D24, L6**

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≠ I am thankful to Prof. Alokesh Barua and Prof. K.L Krishna for the extensive comments and suggestions to the earlier version of the paper. The usual disclaimer applies.

1 Introduction

The main objective of this paper is to examine the impact of international trade on the productivity growth of organised manufacturing sector in India. A number of studies have highlighted the trade-productivity linkage in the manufacturing sector[1]. The economic theory postulates that trade reinforces the drivers of productivity by a more efficient allocation of resources, greater opportunities for economies of scale, competitive pressures and rewarding innovation and providing easy access to new technologies from abroad. Although studies have examined the issue of productivity and trade liberalisation in India, most of them have not tried to disentangle the trade effects on productivity performance. These studies, instead of assessing the various channels of trade productivity linkages, have simply attributed causality by association (See Chand and Sen, 2002). That is, if productivity growth has increased in the post-reform period, then it was presumed to be associated with economic reforms. Several authors have used dummy variable to represent the shift in trade policy regime (see Balakrishnan *et al,* 2000, Milner *et al*, 2007; among others). In contrast, present study, by focussing on the trade-productivity linkages, examines the issue using a disaggregate manufacturing sector data at 4-digit NIC 2004 classification for the period 1980-2007.

The rest of the paper organised in following sections. In section 2, a brief review of literature on trade and productivity with special focus on Indian manufacturing is given. The section 3 presents the econometric methodology followed by a description of data set in section 4. A descriptive analysis of the production, productivity and trade pattern of Indian manufacturing using our sample dataset is given in section 5. The econometric model estimation results are given section 6. The final section 7, summarise the major findings and concludes the discussion.

2 Literature Review

2.1 Trade and Productivity: Theoretical Propositions

The economic theory identifies four channels through which trade can impact productivity. These are discussed as follows.

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[1] See Balassa (1961), Bhagwati (1965) among others, regarding the positive impact of trade on productivity growth. The endogenous growth models consider dynamic effects of trade on productivity (e.g., Grossman and Helpman (1991), Coe and Helpman (1995), Young (1991), Barro (1997) and Frankel and Romer (1999) among others. For a detailed survey of empirical literature for developing countries, see Havrylyshyn (1990) and Edwards (1993) and (1998).

(a) ***Reallocation effects***

International trade enables each country to specialise in the production of those goods and services, which it can produce most efficiently. The traditional theory assumes that trade results in reallocation of scarce resources in favour of more efficient production in line with international opportunity cost and prices (Bhagwati, 1988). As the more efficient import-competing firms survive while the less efficient firms exit, the average productivity growth at the industry level will increase (Hung *et al,* 2004). Further, inexpensive imports will displace domestic production in lower-productivity industries and release domestic resources that can be reallocated to industries with superior technological sophistication. This also increases the average productivity growth. According to Melitz (2003), trade exposure provides access to export markets through lower trade barriers and create new profit opportunities for the most productive firms. As a result, these firms increase factor demand so that factor prices rise. Higher factor prices, in turn, drive the least productive firms out of the market and the most efficient non-exporters become exporters. This increases aggregate productivity and real output in the long run.

(b) Competition effects

One of the likely effects of trade is that it increases competitive pressure in the domestic market. As producers are forced to compete internationally, productive efficiency increases (Weiss, 2002). In the neo-classical model, the competition from increased imports due to lower trade protection will lower prices, which an individual firm faces in the market. This will induce firms to move down the short run cost curve. In the long run, firms will be under pressure to lower costs which will be possible only through investment in new technology. This will shift supply curve downwards (Paus, *et al,* 2003). As noted by Hung *et al, (*2004), as a result of competitive pressures, the domestic firms can improve productivity in a number of ways— by investing in R&D, by corporate restructuring, by learning from foreign competitors through the reverse engineering of their products, or by imitating foreign competitors' production processes.

Another important channel is the reduction of X-inefficiency[2]. According to Nishimizu and Robinson (1984), there is an implicit "Challenge-Response" mechanism induced by competition from trade reforms. The competitive pressure from foreign exposure raises

[2] X-inefficiency refers to intra-firm inefficiency, which can result from such factors as a suboptimal organization of the production process (See Leibenstein, 1966).

the entrepreneurial effort by reducing 'managerial slackness'. X-inefficiency can also reduce due to exit of firms, which are not able to lower their cost in line with the new long run prices[3]. This reduces monopoly rents, drives down margins, and reduces prices for consumers.

(c) Economies of scale effects

In autarky, economies of scale are constrained by the size of the domestic market. Trade removes this constraint by allowing industries and firms to produce on a more efficient scale than otherwise possible. In countries where the size of domestic markets is relatively small, exporting becomes an essential part of achieving scale economies. As a result, firms can experience productivity improvements either from moving the output to a lower cost point on average cost curve or a shift in the average cost curve downward. This will increase the labour productivity of an exporting firm when exports lead to an increase in its output[4] Trade liberalization changes the relative prices between exportables and import substitutes, making exporting relatively more attractive. Increased exports can lead to higher productivity growth through increased awareness of best-practice technology and production techniques abroad as well as their contacts with buyers on the international market (Paus, *et al,* 2003).

(d) Spillover effects

The gains from trade openness advocated by neo-classical models are short run gains. In contrast, the endogenous growth models argue that trade can have dynamic effects through improvement in technological progress. Trade can affect technological progress through changing the structure or specialisation pattern of the domestic industry, facilitating spillover of technology from the trade partner countries and affecting the R&D investment of the firms. Grossman and Helpman (1991) and Young (1991), while highlighting the sectoral difference in generation of technological progress through R&D, learning by doing and human capital accumulation etc, argued that if trade expands the

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[3] In practice, the outcome is not straightforward. According to Tybout (2000) the effects of trade liberalization on the decisions of the individual firm depend on a variety of factors, including industry structure and institutional setting. Exit barriers may slowdown the long-run adjustment process. In addition, firms in import-competing industries may decrease, rather than increase investment, because competition reduces market size and thus the payoff to lowering marginal cost. On the other hand, if domestic competition had previously been sufficient to keep inefficiency low, the effect of liberalization on X-inefficiency would be small (Paus, *et al,* 2003).

[4]Although theoretically appealing, the empirical studies have noted that scale economies can run both ways (See Rodrik, 1992 and Tybout, 1992).

sectors having higher potential to generate technological progress through any of these sources, the industry can experience and sustain long run economic growth.

Trade induces technological spillovers through imports and exports to the trading partner countries (See Grossman and Helpman; 1991, Rivera-Batiz and Romer; 1991). Import of intermediate and capital goods can transmit benefits of new technology from exporting to importing countries. An easier access to lower cost and/or higher quality imported intermediate and capital goods due to trade liberalisation improves productivity through cost reduction. Similarly, import of final manufactured goods from technologically advanced countries allows the less advanced countries to get familiarity with technologically superior and quality products. This induces learning, reverse engineering or imitation in the host country. Likewise, export gives a chance to the firm's of the developing countries to interact with their foreign buyers and learn about new ways to improve the products and production process. This learning helps the firms to adopt best practices to compete in the foreign marketplace (Krueger, 1980).

2.2 Trade and Productivity: Empirics

There is a large body of literature that examines the link between trade and productivity growth using different econometric techniques and data sources. The results are mixed. For instance, Caves and Barton (1990) and MacDonald (1994) using various econometric techniques on U.S data, found a positive association between import penetration and technical efficiency or productivity growth. Some other studies reporting similar results are Edwards (1998) for 93 advanced and developing countries during 1960-90, Benjamin *et al* (2001) for 13 OECD countries during 1980-91 and Andersson (2001) during 1980-95. On the other hand, a few studies have found ambiguous results (See Harrison, 1994; Harrison and Revenga, 1995). The studies that focus explicitly on the impact on productivity growth showed mixed results (see Yean, 1997 and Pavcnik, 2002). Lawrence and Weinstein (1999) reported that imports contributed to TFP increases for Japanese, Korean and US manufacturing firms because of competition effects. However, Muendler (2004) found that the effects of intermediate imports on labor productivity were small for Brazilian manufacturing industry. Kim *et al* (2009) found that imports but not exports have significant positive contribution to TFP for Korean manufacturing plants. The productivity enhancement resulted from increased competitive pressure, exposure to foreign final goods and technology embodied in capital goods imported from advanced countries.

Empirical studies have tried to determine whether exports cause productivity to increase[5]. While a few studies have found evidence to indicate that causality runs from export growth to productivity growth (*e.g.*, Haddad *et al.*, 1996), others suggest that the causality runs from productivity to export growth (see Clerides *et al.*, 1998 and Pavcnik, 2002). Some of the studies that reported positive correlation between exports and productivity are Bonelli (1992), Nishimizu and Robinson (1984) and Weinhold and Rauch (1997). However, these studies did not clarify whether this is due to economies of scale, technological innovation, or other factors. Choudhri *et al* (2000) for 33 developing countries for 1970-93 found that productivity growth effect of trade openness depends upon sector specific characteristics. Thangavelu *et al* (2004) using a vector error correction model for nine rapidly developing Asian countries, including India, found that imports have a significant effect on labour productivity growth. This suggests that in Asian countries, import-led growth is prevalent. They further noted that exports and imports have qualitatively different impacts on labour productivity across different countries.

2.2.1 Trade and Productivity Growth in Indian Manufacturing Sector: The Evidence

Goldar (1986) studied the effect of restricted trade policy on industrial productivity and found that import substitution negatively affected productivity growth. By taking for 63 three-digit industry groups from the Annual survey of Industries (ASI), Ahluwalia (1991) examined the effect of import substitution on total factor productivity growth (TFPG) using growth accounting and econometric estimation of production function. She found that there was a negative relationship between the degree of import substitution and the rate of growth of TFP during 1960-80. Although TFPG was relatively poor during 1965-80, it witnessed a turnaround during the first half of the eighties. She attributed this to the initial liberalisation policy measures adopted by India. The author found that. However, Balakrishnan and Pushpangadan (1994) challenged Ahluwalia's claim of acceleration in TFP during trade liberalisation period. They highlighted several methodological issues related to productivity calculation.

Das (1998) analysed the effect of output growth, import penetration rate and export growth on TFPG using a panel data of 53 three-digit level industries for the period 1980-93. The results showed that the import penetration rate had significant negative effect on TFPG in five cases. The export variables (measured by export growth rate and ratio of

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5 For a literature survey, see Greenaway and Sapsford (1994).

export to output) were significant only in one case out of 36 regressions estimated. Das (2004), using a panel of 75 three digit industry product groups found that an increase in factor accumulation rather than TFPG account for growth in output during 1980-00. However, the author found an improvement in TFPG during the latter half of the 1990s for some of the major industrial sectors, especially the capital goods sector, thus, supporting the lag effect of trade policy reform. Goldar and Kumari (2003) examined the effect of effective rate of protection and non-tariff barriers on TFPG using a panel of 17 two-digit industries for the period 1980-81 to 1997-98. The results showed that effective rate of protection has a significant and robust negative effect on TFPG. The study concludes that restrictive trade policy retarded the productivity growth in Indian manufacturing. Chand and Sen (2002), taking a subgroup of 30 three-digit industry groups, observed that a fall in the ratio of domestic to international prices has a significant positive impact on productivity growth during 1970-88.

Sen (2009), following the methodology adopted by Chand and Sen (2002), examined the role of trade policy on manufacturing TFP using 3-digit ASI data for the period 1973-98. He found that a reduction in quantitative restrictions had a positive effect on TFPG. In addition, a reduction in price distortions along with an increase in intra-industry trade in intermediate and capital goods has had a strong positive impact on TFP. Milner *et al* (2007) examined the effect of trade liberalisation on TFP of Indian manufacturing sector for the period 1984-98. The study used ASI data and covered 159 industries at 3-digit level. Using a simple pre and post reform methodology, the study found that TFPG in the manufacturing sector has improved during the reform period. Sengupta and Neogi (2009), by examining five manufacturing sectors from ASI, found that an increase in export share has positive effect on TFPG.

The link between trade liberalisation and productivity has also been analysed using firm level data from the Centre for Monitoring Indian Economy (CMIE). Krishna and Mitra (1998), using firm level data for 362 firms, noted that returns to scale and price-cost mark up has declined in technology intensive sectors, like Non-electrical machinery, electronics and transport equipments. The increased competition in these industries was associated with an improvement (weaker) in productivity growth since economic reforms. However, Balakrishnan *et al* (2000), for a panel data of pooled sample of 2300 firms of five industries, *viz*, electrical machinery, non-electrical machinery, transport equipment, chemicals and textiles, reported that during 1989-98 there was no evidence of acceleration of productivity growth. In both these studies, trade policy changes were proxied by dummy variables.

Srivastava (2001) analysed the issue of trade policy reforms on productivity performance of Indian firms during 1980-97. He used panel data set of 3100 firms from RBI and classified them into 17, two digit categories. He found that at the aggregate level, both growth accounting and econometric estimation revealed a significant decline in TFPG during the 1990s. The result was not uniform across sectors but he noted that consumer durable goods fared relatively better compared to other segments of the economy. Recently, Topalova and Khandelwal (2011) found that increased firm efficiency because of an increase in competitive pressure from lower output tariff and an increase in the volume of imported inputs has lead to higher productivity in Indian manufacturing sector. The study acknowledged that the lower inputs tariffs eased the domestic firms' access to cheap and quality imported inputs from the world market.

3 Econometric Methodology

As we noted in the theoretical literature, trade-induced channels that can affect productivity growth are economies of scale effects, competition effects, reallocation effects and spillover effects. The first two channels directly affect firm level productivity while the latter two affect productivity growth at the aggregate level. The first three channels affect labour productivity both directly and through their impacts on TFP, while the last channel affects labour productivity mainly through its impact on TFP (Hung *et al*; 2004).

The reduction in tariff barriers due to trade liberalisation results in inflow of foreign products in the domestic market. This increases competition in the domestic market. This will force the domestic import competing manufactures to improve productivity by reducing x-inefficency, adopting best practise technology, increasing in-house R&D expenditure, management restructuring, reverse engineering or imitation of foreign competitor's production techniques. In order to capture the competitive channel we use relative import price (RP). RP is the price of import relative to domestic price. We expect that a reduction in relative import price by intensifying competitive pressure will improve manufacturing productivity growth.

The imports provide the domestic producers an opportunity to use foreign materials in their production process. The domestic industries can use cheap capital goods like machine tools in their production and improve productive efficiency. The use of machinery as inputs facilitates diffusion of foreign technology, learning and imitation in the domestic manufacturing sector. This will help in reallocation of resources into more productive activities. As more efficient firms survive the competition and the less efficient import competing firms are forced to exit the market, one can expect an increase in average productivity at the industry level (Hung *et al*; 2004) Thus, imports generate competition, reallocation and spillover benefits to the domestic industrial sector. We capture these channels with import penetration (IMP) ratio. The IMP shows the proportion of the market for a particular type of good that is supplied by imports. We expect that an increase in IMP will enhance industrial productivity.

Industries can experience scale economies by producing for export market. The increased market opportunity helps industries to lower cost and increase labour productivity. Increased investments in technology intensive activities like R&D further shifts cost curve downwards. As a result, resources will be reallocated to technologically superior productive activities which results in an increase in average industrial productivity. Exporting to foreign markets induces positive learning effects as exposing the domestic firms to advanced technological innovations from international buyers and competitors helps them to improve productivity[6]. The aggregate knowledge may also increase with spillover benefits to domestic firms if firms learn to use the advanced methods and process techniques of foreign producers. These mechanisms can augment average industrial productivity of the domestic economy. The measure of export intensity (EXI) of industries that reflects economies of scale effect, reallocation effect and spillover effects is expected to have positive impact on productivity growth.

In order to model the trade induced productivity effects, we use an econometric model suggested by Hung *et al,* (2004). We extend the model by incorporating capital intensity (CI) as an additional explanatory variable. In the Indian context, several empirical studies have noted the importance of capital intensity in productivity growth[7]. Apart from trade related variables, we use capacity utlisation (CU) variable to control for the pro-cyclical nature of

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[6] This is learning-by-export hypothesis. See Bernard and Wagner (2001) for further details. An alternative argument is self-selection hypothesis (See Melitz, 2003). It argues that only productive industries enter export market. This is due to the sunk costs in entering and selling in foreign markets. Moreover, the exporting industries have to face intense competition in the world market.

[7] Isaksson (2007) argues that capital intensity is the main determinant of TFP and the benefit of technology transfer through international trade depends on absorptive capacity in the domestic sector. This capacity is mainly dependent on human capital and capital intensity (Isaksson, 2007).

TFP[8]. Thus, we relate productivity growth (*P*) of an industry into relative import price (*RP*), import penetration ratio (*IMP*), export intensity (*EXI*), capital intensity (*CI*) and capacity utlisation (*CU*). That is:

$$P_{j,t} = f(RP, IMP, EXI, CI, CU) \qquad ---(1)$$

where *j* refers to industry, *t* refers to year. We use appropriate econometric methodology to test the hypothesis that a relatively greater international exposure to trade leads to a relatively greater growth in productivity in an Indian industry. We conduct the empirical analysis using the balanced panel data[9] for 62 four-digit industries for the period 1980-2007. In order to understand the impact of trade on productivity (*P)*, the analysis focuses on two main productivity indicators, namely labour productivity (LP) and total factor productivity (TFP). The model is given in equation (2)

$$\Delta ln\, P_t = \alpha + \beta_i \Delta lnRP_{t-i} + \gamma_i \Delta lnIMP_{t-i} + \delta_i \Delta EXI_{t-i} + \vartheta \Delta lnCI_t + \theta \Delta CU_t + \mu_t \quad --(2)$$

where,

α = constant representing the trend growth in industry

$\Delta lnP_{j,t}$ = the relative change in TFP or labour productivity in industry at time *t*

$\Delta lnRP_{j,t}$= the percent change in relative import price in industry at time *t*

$\Delta lnIMP_{j,t}$= the first difference in the import penetration ratio for industry at time *t*

$\Delta EXI_{j,t}$= the first difference in the export share in industry at time *t*

$\Delta lnCI_{j,t}$= the percent change in capital intensity

$\Delta CU_{j,t}$= the first difference in capacity utilization in industry at time *t*.

i = lags assumed in the model (see below)

The constant term α_j is included to control for the average productivity growth trend in industry *j*. As mentioned earlier, we include CU_t to account for the procyclicality of

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[8] There are several reasons for productivity to be procyclical. (i) If there are high frequency fluctuations in technology, output will be cyclical. (ii) An imperfect competition and increasing returns to scale may lead productivity to increase whenever input rises. (iii) Resource utlisation may vary over the business cycles (iv) The reported labour and capital figures tend to overstate the true amount of inputs in downtimes, giving rise to the procyclicality in measured productivity. See Basu and Fernald (2001) for a discussion on procyclical nature of productivity.

[9] Panel data are most useful when we suspect that the outcome variable depends on explanatory variables, which are not observable but correlated with the observed explanatory variables. If such omitted variables are constant over time, panel data estimators allow to consistently estimate the effects of the observed explanatory variables (Schmidheiny, 2012).

productivity growth in industry *j*. We expect θ to be positive[10]. A negative β_i would suggest that decreases in import prices by intensifying competitive pressure, help to promote manufacturing productivity. Similarly, we would expect a positive γ_i since the competition effects, reallocation effects and spillover effects all suggest that a rise in import penetration would help promote productivity growth. A positive δ_i would indicate that productivity growth tends to increase when exports become a larger share of total production. This would be consistent with the economies-of-scale channel the reallocation channel, and the spillover channel. Finally, a positive ϑ suggests that productivity growth is positively associated with an increase in capital intensity in the industry.

So far, we have discussed the impact of trade on productivity by implicitly assuming that the outcome is instantaneous. This may not be true in all cases. In some industries, the resource allocation, spillover effects or technological upgrading may not take place immediately. As a result, the impact of trade on productivity will result only after a lag. Therefore, we incorporate the dynamic link between trade and productivity by estimating different variants of equation 2. Specifically, we estimate equation 2 for three cases:

(a) i = 0, n = 0 (no lag), (b) i = 1, n = 1 (one year lag) and (c) i = 2, n = 2 (two year lag)

In the first model (a), we assume instantaneous relationship between trade and productivity growth. In the second model (b), we assume that trade affects productivity growth with 1-year lag. In the last model (c), we expect trade to impact productivity growth after 2-year gap. We estimate equation (2) using fixed effect(s) (FE) and Random effect(s) (RE) methods. We use the Hausman specification test to choose between FE and RE method.

4 Data Sources and Construction of Variables

The empirical analysis requires data related to industry and trade statistics. We have collected the industry statistics according to the various National Industrial classifications (NIC) from ASI published by Central Statistical Organisation (CSO)[11]. We have used the Volume 1 of ASI, which contains the summary result of registered factory sector at two, three and four digit industrial classification level. Since NIC structure reshuffled four times during the study

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[10] By including α_j and $CU_{j,t}$ in the panel regression, we aim to estimate the effects of international exposure on productivity growth beyond and above what can be accounted by the trend growth and cyclical fluctuations (Hung *et al*, 2004).

[11] ASI reports the survey of registered (or organised) manufacturing sector activities in India. The ASI data consist of two series: (i) the Census sector and (ii) the Factory sector. For a recent account of industrial statistics, strength and weaknesses see Manna (2010) and Nagaraj (1999).

period, a concordance Table, provided by ASI, was used to build a continuous database for all the selected industrial sectors and variables at the four digits NIC 2004[12].

The primary source of India's trade statistics is The Directorate General of Commercial Intelligence and Statistics (DGCI&S), which compiles and publishes export & import data on merchandise trade. Before 1987, DGCI&S was following Indian Trade classification or (ITC[13]). DGCI&S adopted Harmonized Commodity Description and Coding System (Harmonized System, or HS) in 1988. Since then, it provides trade statistics based on the HS classification. We use Standard International Trade classification scheme (SITC), which is available from United Nations Commodity Trade Statistics Database or COMTRADE online databases of The United Nations Statistical Division (UNSD). We accessed UN COMTRADE database through World Integrated Trade Solution (WITS)[14]. Since trade statistics and industry statistics are reported according to different classification scheme, we prepared a trade-industry concordance.

4.1 Trade-Industry Concordance (1980-2007)

For 1980-87, we followed the concordance Table prepared by Debroy and Santhanam (1993). Here the matching was prepared between NIC 1987 and ITC rev2[15]. We collected trade data based on SITC rev2 for the period 1980-87[16]. For the remaining period (1988-2007), we collected trade data based on SITC Rev3. In order to use SITC Rev3, we prepared a correspondence Table between SITC Rev3 and ISIC Rev3 based on the concordance

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[12] We have used three-concordance tables provided by ASI publication, namely NIC 1987, NIC 1998 and NIC 2004. We could not extend the period beyond 2007 as the recent classification (NIC 2008) has drastically changed its product codes, which makes it virtually impossible to identify 4-digit product groups with earlier 3-digit product groups. See the detailed product list in table A1 in the appendix.

[13] The ITC was designed according to Standard international trade classification (SITC rev1 and rev2). For a detailed account of trade and industrial statistics, see the section 'Commodity classification' in UN (1998).

[14] WITS is a data consultation and extraction software with simulation capabilities. World Bank developed it by collaboration in and consultation with United Nations Conference on Trade and Development (UNCTAD), International Trade Center (ITC), United Nations Statistical Division (UNSD) and World Trade Organization (WTO).

[15] ITC rev2 is based on SITC rev2. The industry product groups during 1980-87 were at 3-digit product groups. It has to be noted that the same 3-digit product groups were reclassified as 4-digit groups in NIC 1998/2004.

[16] We have found that in some cases, the number of industries at 3-digit NIC 1987 corresponds to 7-digit SITC codes. Since trade data at this level of disaggregation was not accessible from COMTRADE, we have used the corresponding 5-digit SITC data. This is also a reason for us to restrict SITC rev2 data until 1987. For the remaining period (1988-2007), we used SITC rev3 data, which is free from the aggregation problem.

provided by UN[17]. We use ISIC Rev3 because NIC 1998/2004 at 4-digits is based on ISIC Rev3. Therefore, we collected SITC Rev3 data of India's merchandise trade data from UN COMTRDE. The concordance between NIC 1998/2004 (or ISIC rev3) and SITC rev3 is given in Table A2 in the appendix.

4.2 Construction of Variables

(i) Relative change in TFP or labour productivity (*P*)

We measure TFP using a value added function under growth accounting framework[18]. The value added at any year by any particular industry can be given by $V_t = f(L_t, K_t)$ where K_t represent the physical capital of the and L_t is total amount of labour employed. The Translog index of TFP growth is given by the equation 3.

$$\Delta \ln TFP_t = \Delta \ln V_t - \left((s_{Lt} + s_{Lt-1})/2\right) \Delta \ln L_t - \left((s_{Kt} + s_{Kt-1})/2\right) \Delta \ln K_t \quad --- (3)$$

Where V, L and K denote value added, labour input and capital input respectively. $\Delta \ln V_t = \Delta \ln V_t - \Delta \ln V_{t-1}$. The share of labour income in value added in period t is s_{Lt} and that of capital is s_{Kt}. The share of capital income in value added in period t is defined as $(1 - s_{lt})$. The share of capital and labour add to unity. The labour productivity is defined as the ratio between a volume measure of output (value added) and a measure of input use (total person engaged). We have converted the nominal value added reported in the ASI database to real value added using the appropriate wholesale prices of output, base 2004-05=100. We have taken total person engaged as the labour input measure. We constructed the real capital stock at 2004-05 prices using the perpetual inventory method. In order to convert the book value of fixed capital to replacement capital, we follow the method suggested by Goldar (1986) and Banga and Goldar (2007).

(ii) Relative Import Price (*RP*)

In order to construct relative import prices (i.e. import prices relative to domestic prices), we require information about the domestic prices of the industries as well as import

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[17] UN has prepared correspondence between ISIC (rev2 and rev3) with various trade classifications such as SITC, HS and BEC. These are freely available for download from UN website. For online access, see: http://unstats.un.org/unsd/cr/registry/regsale.asp?Lg=1

[18] Most of Indian studies on productivity estimation have used growth accounting method of assessing TFPG. For instance, see Ahluwalia (1991), Balakrishnan and Pushpangadan (1994), Goldar (2000), Trivedi *et al* (2000), Goldar and Kumari (2003), Das (2004), Bosworth *et al* (2007) among others.

prices. We use unit value index (UVI) for constructing import price series for Indian manufacturing industrial product groups. The construction of UVI follows Paasche's formula, which uses import quantities in the current period as weights. The UVI calculation formula is given in equation 4

$$UVI_{jt} = \frac{\sum_i UV_{jti} Q_{jti}}{\sum_i UV_{j0i} Q_{jti}} \quad --- (4)$$

where UV_{jt} is unit value of import for industry j in period t, UV_{jo} is the base year import unit value, Q_{jt} is the import quantity for industry j in period t. We calculated unit value of imports (UV_{jt}) by dividing the import value (V_{jt}) by aggregate quantity(Q_{jt}). The relative import price (RP) was derived by dividing the import unit value index (UVI) by the wholesale price index (WPI) for each of the industrial product group (See equation 5).

$$RP_{jt} = \frac{UVI_{jt}}{WPI_{jt}} \quad --- (5)$$

(iii) Import Penetration (*IMP*)

The import penetration rate (IMP) is defined as the ratio of total imports to domestic demand or apparent consumption (the difference between output and exports), as percentage. This is given in equation 6.

$$IMP_{jt} = \left(\frac{M_{jt}}{(Q_{jt} + M_{jt} - X_{jt})} \right) * 100 \quad --- (6)$$

Here, j refers to industry and t is period (1980-2007). M is the import value, X is export value and Q is the value of domestic industrial production. All values are in current prices. We converted the industrial output data, which is available in Rupees, into US dollar using the average exchange rate (financial year) of India and US available from RBI.

(iv) Export Intensity (*EXI*)

The export intensity (EXI) is the ratio of exports to total production, defined as percentage. We calculated EXI by dividing the export value (EX) by the output value (Q)

$$EXI_{jt} = \frac{EX_{jt}}{Q_{jt}} \quad --- (7)$$

where j denotes industry and t time. EX is export value and P is output. All values are expressed in current prices. Since the value of output from ASI is in Rupees, we converted them into dollar denomination using the average exchange rate of India and US.

(v) Capital Intensity (*CI*)

The capital intensity denotes the amount of real capital (K) present in relation to other factors of production, especially labour (L). We calculated capital intensity (*CI*) using the formula 8.

$$CI_{jt} = \frac{K_{jt}}{L_{jt}} \qquad ---(8)$$

where K_{jt} is real capital stock for industry j for period t, L_{jt} is the total number of labour force employed in industry j in period t.

(vi) Capacity Utilisation (*CU*)

We derived the capacity utilisation ratio using the minimum capital-output ratio, which has been used by Uchikawa (2001) and Goldar and Kumari (2003) in the past. The formula for capacity utilisation rate is given in equation 9.

$$CU_{jt} = {Q_{jt}}/{\overline{C_{jt}}} \qquad ----(9)$$

Q is the actual output represented by gross output and $\bar{C}$ is the estimate of capacity output. The estimated capacity was derived using equation (10)

$$\bar{C}_{jt} = \frac{K_{jt}}{\left(\frac{K_j}{O_j}\right) min} \qquad ---- (10)$$

K is the estimated real fixed capital stock and $\frac{K_j}{O_j}$ is the observed lowest capital-output rate for industry j during the reference period.

5 Descriptive Statistics

For the descriptive analysis, we have classified the selected 62 four digits industries into four technology intensity categories, i.e., High technology (HT), Medium high technology (MHT), Medium low technology (MLT) and Low technology (LT), based on OECD (2011).

Table 1 shows the industry and trade share of each technology intensive industries in the aggregate manufacturing (i.e., total of 62 sectors) during 1980-90, 1991-00 and 2000-07 and 1980-2007. During the three decades, the production structure has gradually moved towards MLT and MHT sectors. In recent years, the output of LT sector has decelerated. Not surprisingly, India does not have much presence in the HT sector during the entire period.

Table 1
Percent Share and average annual growth rates of Manufacturing Output, Exports and imports (by Technology Intensity) (%)

Category	Trade Flow	1980-90	1991-00	2001-07	1980-2007
HT	Output	5.0 (13.5)	5.4 (31.6)	7.3 (15.1)	5.7 (20.2)
	Exports	4.6 (13.7)	6.1 (7.8)	6.9 (17.2)	5.7 (12.4)
	Imports	9.0 (0.9)	9.6 (4.4)	13.5 (18.4)	10.4 (6.7)
MHT	Output	24.9 (17.4)	27.2 (12.4)	28.6 (14.4)	26.6 (14.9)
	Exports	16.4 (9.4)	18.7 (9.5)	23.8 (19.0)	19.1 (11.9)
	Imports	46.7 (7.6)	43.0 (3.3)	37.8 (19.6)	43.2 (9.1)
MLT	Output	16.9 (23.8)	16.3 (13.8)	27.2 (20.1)	19.4 (19.3)
	Exports	8.0 (9.4)	11.6 (7.8)	27.3 (27.8)	14.1 (17.1)
	Imports	28.0 (7.6)	36.9 (4.1)	37.5 (19.6)	33.6 (8.2)
LT	Output	22.5 (31.0)	21.4 (22.4)	18.4 (18.7)	21.1 (24.7)
	Exports	71.0 (7.5)	63.6 (7.8)	42.0 (8.7)	61.1 (7.9)
	Imports	16.2 (-2.6)	10.5 (6.2)	11.2 (12.2)	12.9 (4.5)

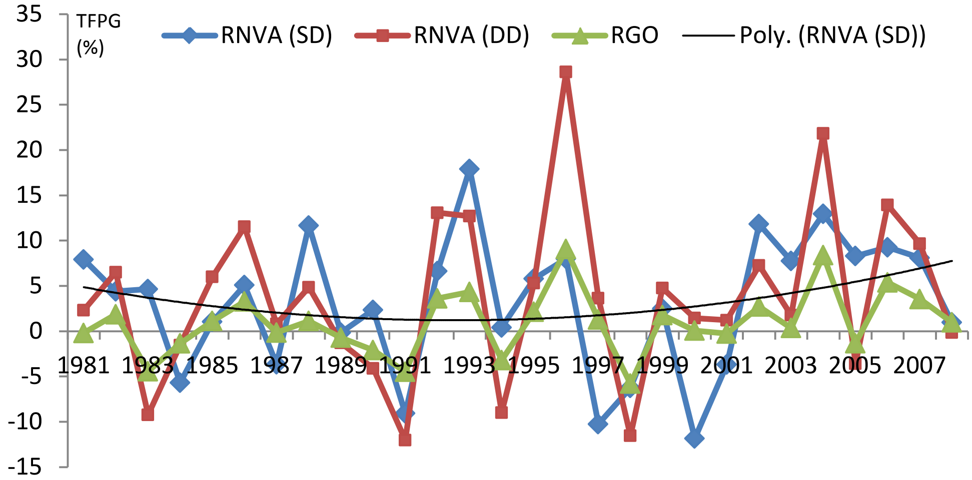
Note: Figures in brackets represent average annual growth rates. HT: High Technology Industries, MHT: Medium-high Technology industries, MLT: Medium low Technology industries, LT: Low Technology Industries, Technology classification is taken from OECD (2011). Output denotes the net value added at current prices.
Source: Authors calculations based on ASI (CSO) and UN Comtrade (WITS)

In export sector, we can see the dominance of LT product groups during the entire period of the study (60 percent during 1980-2007). However, the LT sector share has decelerated in the recent period. On the other hand, MHT and MLT witnessed an improvement in recent period. In contrast, MHT (43 percent during 1980-2007) and MLT (34 percent during 1980-2007) product groups dominate the Indian import basket. The share of HT product also witnessed an increasing trend and represented a 10 percent share in the total manufacturing imports. On the other hand, LT witnessed a declining trend and represented 13 percent average share during 1980-2007. This suggests that generally, India's imports are more technology intensive and the export baskets are less technology sophisticated. A disaggregate analysis revealed that some of the major export industries during 1980-2007 were Textiles, tea and fish, industry chemicals, heavy motors, Iron & steel and drugs and pharmaceuticals. (See Table A3 in the appendix)[19]. During this period, India has been a

[19] In these Tables, we have provided the share of the individual products in two ways. In each period, we have found two average share values for each the products. One is the average share of each

major importer of refined petroleum products, electrical and non-electrical machinery, copper & aluminium products, industrial organic and inorganic chemicals, fertilizers and pesticides, office computing machinery and Aircraft and spacecraft parts.

Figure 1
TFPG in India Manufacturing (%)



Source: Author's calculation based on data collected from ASI

Table 2
Productivity growth rate of 4-digit industries:
By Technology Intensity (1980-2007) (% per annum)

Technology category	Indicator	1980-90	1991-00	2001-07
HT	TFP	0.8	2.6	0.7
	LP	10.2	18.5	12.1
	CI	12.5	14.2	5.9
MHT	TFP	-1.1	-0.3	4.7
	LP	12.5	15.7	11.3
	CI	10.7	11.3	5.2
MLT	TFP	-2.8	-0.7	9.5
	LP	18.8	12.1	18.5
	CI	17.5	9.0	5.6
LT	TFP	-0.2	-0.7	0.4
	LP	5.8	5.5	3.4
	CI	16.9	10.1	5.1

Note: LP: Labour productivity, TFP= Total factor productivity, CI: Capital Intensity, HT= High technology intensive industries, MHT=Medium high technology intensive industries, MLT=Medium low technology intensive industries, LT=Low technology intensive industries.
Source: Author's calculation based on data collected from ASI

The productivity growth in the aggregate as well technology segment of Indian manufacturing sector is given in Table 2 and 3. As noted by several studies in the past, we

product in the total technology export/import. Another figure (in brackets) shows that average share of these products in aggregate (selected 62 industries) export/imports for the reference period.

also found negligible TFPG (below unity) during 1980s and 1990s. However, the productivity has improved to 4 percent per annum during 2001-07 (See Table 3). During 2001-07, both MLT and MHT witnessed significant improvement in TFPG. Compared to 1990s, the growth rates of labour productivity in MLT segment improved while capital intensity decelerated in all technology product groups in 2000s (See Table 2). During the entire period, the rate of growth of TFP has continuously fluctuated (See figure 1). A similar pattern is observed at the disaggregate level based on technology intensity (See figure A1 in the appendix).

Table 3
Average annual growth rates: Trade and productivity variables (1980-2007)

Variables	1980-90	1991-00	2001-07	1980-07
TFPVA	-0.8	0.2	3.8	0.8
LPVA	11.8	12.9	11.3	12.1
RP	2.3	1.9	7.0	3.4
IMP	17.3 (68.2)	2.4 (74.5)	6.1 (89.7)	12.3 (77.4)
EXI	12.4 (32.5)	4.5 (49.7)	5.6 (63.7)	7.5 (48.6)
CI	13.7	10.0	5.4	10.0
CU	-6.3	-1.5	2.4	-2.1

Note: Figure in brackets represents the average share during the reference period. The growth rates are based on 62 four-digit industries. TFPVA= TFP based on value added framework, TFPGO= TFP based on gross output framework, LPVA= labour productivity based on value added, RP= Relative import price index, IMP=Import penetration ratio (%), EXI=Export intensity (%), CI=Capital intensity index, CU= Capacity utlisation rate (%).

In Table 3, we provide the growth rates of our main analysis variables for all the 62 manufacturing industries. The summary statistics of all selected variables are given in Table A4 in the appendix. We can see that, during 1980-2007, the overall growth rates of TFP were rather low. The labour productivity growth was significantly higher than TFP during various sub-periods. The capital intensity growth rates showed a marked decline during 2001-07. The growth in capacity utlisation was negative during the 1980s and the 1990s but improved since 2000 onwards. Compared to the 1980s and the 1990s, the growth rates of relative import prices for the manufacturing sector were higher during 2001-07. The relative price of imports increased for all different technology segments of manufacturing during this period (see figure A2 in the appendix). During the three sub-periods, the shares of import penetration and exports have increased considerably. The increasing share of import penetration in Indian manufacturing implies that the domestic demand has been largely satisfied through imports. We can see from Table 3 that, during the 1980s, import penetration witnessed major growth but decelerated during the 1990s but improved since 2001. Similar pattern is visible for export intensity variable. Although the export intensity in domestic manufacturing has increased during the three sub periods, the rate of growth was lower during in the nineties. However, the growth rates improved during 2001-07.

6 Model Estimation Results

As explained in the methodology section, the empirical analysis is carried out using panel regression method. In order to understand the dynamic relationship between trade and productivity growth, we created lags of trade related variables. We employed both fixed effect(s) and the random effect(s) methods. Based on the Hausman specification test, we selected the random effects model for estimation[20]. Therefore, our presentation and discussion of the regression results focuses on the random effect(s) method[21]. For robust results, we use Huber-White standard errors, which are robust for the presence of panel heteroscedasticity and autocorrelation[22]. In the following sub-section, we will discuss the econometric results. In all four Tables, the coefficient estimate on capacity utlisation (ΔCU) is positive and statistically significant. The finding confirms the procyclicality of both TFP and LP growth.

6.1 Results of Trade and Productivity Growth Relationship: 4-digit Industry Sample

We estimate equation 2 for 62 four-digit industries. In the first period (no lag), we have 1674 observations. In the second period (1-year lag), we have 1612 observations and for the last period (2 year lag), we have 1550 observations. The random effect estimation results for TFP is given in Table 4 and LP estimation results are given in Table 5.

(i) Total Factor Productivity Growth

(1) A decline in relative import price (ΔRP) does not have a significant impact on productivity growth of import competing industries in the current period. This is evident in Table 4 where we can see that coefficient estimates are positive but not significant. However, during the second period (1 year lag), a decrease in ΔRP has positive and significant impact

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20 In the random effect(s) model, the individual-specific effect is a random variable that is uncorrelated with explanatory variables.

21 We found that the estimate results of both fixed effect model and random effect models are very similar. This suggests that our inferences are not sensitive to the choice of the estimation technique.

22 Assuming independently distributed residuals, the standard errors obtained by the Huber-White procedure are consistent even if residuals are heteroskedastic. Rogers (1993) relaxed the assumption of independently distributed residuals, and showed that the Huber-white procedure produces consistent standard errors if the residuals are correlated within but uncorrelated between clusters. In STATA, the standard error estimates based on clusters and robust option produces the same results. See Hoechle (2007) for an overview of robust standard error for panel regression models in STATA.

as the coefficient estimate is -0.038 and significant at 5 percent level. In the last period, relative import prices have no impact on TFP.

Table 4
Panel Regression of productivity growth in Indian manufacturing sector
(4-digit industries sample) 1980-2007
Dependent variable TFPG based on value added framework: $\Delta \ln P\ (VA)$

Explanatory Variables	**RANDOM EFFECTS**		
	(i) No Lag	(ii) 1-year Lag	(iii) 2-Year Lag
ΔRP	0.034 (0.022)	-0.038** (0.018)	0.025 (0.023)
ΔIMP	-0.031 (0.053)	0.104* (0.057)	0.181 (0.132)
ΔEXI	-0.207 (0.197)	0.056 (0.130)	0.253** (0.116)
ΔCI	0.062 (0.058)	0.059 (0.059)	0.058 (0.059)
ΔCU	1.493*** (0.149)	1.537*** (0.157)	1.551*** (0.160)
constant	2.388*** (0.854)	2.455*** (0.866)	1.689** (0.856)
R^2	0.38	0.37	0.37
Wald test	165.21 (0.0000)***	146.9 (0.0000)***	163.84 (0.0000)***
Hausman	0.46 (0.9935)	0.64 (0.9863)	0.25 (0.9985)
No of observations	1674	1612	1550
No of industries	62	62	62

Notes: (1) Contemporaneous coefficient estimates on ΔCU and ΔCI for all columns. In column (b), coefficient estimates are for 1-year lag; in column (c), coefficient estimates are for 2-year lag. (2) The Huber-White robust standard errors are given in parentheses under estimated coefficients (3) p-values are given in parentheses under chi^2 – statistics for Wald test statistic. (4) Hausman statistic is asymptotically χ^2 distributed with p-values in brackets. (5) * significant at 0.01 level for a two-tailed test, ** at 0.05 level for a two-tailed test, *** significant at 0.1 level for a two-tailed test. (6) RP, relative import price; IMP, import penetration; EXI, exports share in total output; CI, capital intensity in production; and CU, capacity utilization.

(2) In the short period, an increase in import penetration (ΔIMP) has no impact on TFPG. The coefficient is negative (-0.031) but not statistically significant. This implies that the negative economies of scale effects of an increase in import penetration outweigh its productivity enhancing effects (competition effects, reallocation effects and spillover effects). However, in the second period, the productivity enhancing effects are more dominant as the estimates of ΔIMP is positive and significant at 10 percent level. During the third period (2 year lag), we see that import penetration is positive but not significant. Thus, we have some evidence to argue that import penetration increases productivity growth. The positive effect of competition, reallocation and spillover channels operate only after a lag.

(3) In the current period, export intensity (ΔEXI) does not have an impact on TFP. The positive effect of reallocation, economies of scale and spillover channels associated with export intensity materialize only after 1-2 years. The coefficient estimates is positive (0.253) and significant at 5 percent level after 2-year.

(4) We find that the coefficients estimates of capital intensity (ΔCI) are positive but not significantly correlated with TFP either contemporaneously, or with lags.

(ii) Labour Productivity Growth

(1) A decrease in relative import price (ΔRP) is not significantly associated with labour productivity growth, either contemporaneously or with lags. Although the coefficient estimates becomes negative in 1-2 years, it is not statistically significant (See Table 5).

Table 5
Panel Regression of productivity growth in Indian manufacturing sector
(4-digit industries sample) 1980-2007
Dependent variable Labour productivity growth: $\Delta \ln LP$

Explanatory Variables	**RANDOM EFFECTS**		
	(i) No Lag	(ii) 1-year Lag	(iii) 2-Year Lag
ΔRP	0.004 (0.032)	-0.036 (0.024)	-0.014 (0.020)
ΔIMP	-0.081* (0.046)	0.096** (0.045)	0.121 (0.093)
ΔEXI	-0.289* (0.162)	0.397** (0.184)	-0.264 (0.169)
ΔCI	0.399*** (0.115)	0.394*** (0.116)	0.389*** (0.118)
ΔCU	1.814*** (0.150)	1.874*** (0.154)	1.900*** (0.161)
constant	10.446*** (1.347)	10.211*** (1.324)	10.158*** (1.364)
R^2	0.42	0.42	0.41
Wald test	260.33 (0.0000)***	227.04 (0.0000)***	202.84 (0.0000)***
Hausman	0.61 (0.9877)	0.64 (0.9860)	0.18 (0.9993)
No of observations	1674	1612	1550
No of industries	62	62	62

Notes: (1) Contemporaneous coefficient estimates on ΔCU and ΔCI for all columns. In column (b), coefficient estimates are for 1-year lag; in column (c), coefficient estimates are for 2-year lag. (2) The Huber-White robust standard errors are given in parentheses under estimated coefficients (3) p-values are given in parentheses under chi^2 – statistics for Wald test statistic. (4) Hausman statistic is asymptotically χ^2 distributed with p-values in brackets. (5) * significant at 0.01 level for a two-tailed test, ** at 0.05 level for a two-tailed test, *** significant at 0.1 level for a two-tailed test. (6) RP, relative import price; IMP, import penetration; EXI, exports share in total output; CI, capital intensity in production; and CU, capacity utilization.

(2) The increased import penetration (ΔIMP) in the manufacturing sector is associated with low labour productivity growth in the current period. The coefficient estimates of ΔIMP is negative (-0.081) and significant at 10 percent level. Sustained imports, however, augment labour productivity after 1 year. We can see that with 1 lag, the coefficient estimates is positive (0.096) and significant at 5 percent level. In the following period, the coefficient is positive but not statistically significant.

(3) In the current period, export participation hampers labour productivity. We find that in the first period, the coefficient estimate of export intensity (ΔEXI) is negative (-0.289) and significant at 10 percent level. As ΔEXI continues to increase, the labour productivity growth improves. This is evident from a positive (0.397) and significant (5 percent level) coefficient estimates of ΔEXI after 1 year lag.

(4) The coefficient estimates of capital intensity (ΔCI) is positive and significant in all time period. This confirms our observation that an increase in capital intensity has a positive and significant effect -both quantitatively and statistically- on labour productivity growth, contemporaneously and with lags.

To check the *robustness* of the results, we employed alternative specification of TFP based on gross output. We found that the findings are largely robust (see Table A5 in the appendix).

Thus, we can conclude by highlighting some of the major findings of the study as follows:

(a) Trade has sizeable impact on organised manufacturing productivity of India. The trade induced transmission channels, like reallocation effects, economies of scale effects, spillover effects and competitive effects are more pronounced on TFP through imports than exports.

(b) We find that imports and to a lesser extent exports affect productivity only after a lag. However, in the long period, the productivity benefit is not sustained. The results vary across different specification of productivity growth as well as for different levels of disaggregation.

(c) There is some evidence to argue that export participation and import penetration has adverse impact on labour productivity in the short run. This trend is reversed only during the second period. Thereafter, both have no significant role in enhancing labour productivity. In contrast, capital intensity is positive, highly significant and persistent over time.

6.2 Comparison with earlier studies

As we have used the methodology Hung *et al* (2004), it is important to compare our result with that of that study. The empirical analysis of Hung *et al* (2004) shows a significant positive role for import prices in the US manufacturing sector. They found weak evidence of economies of scale effects and spillover effects based on export intensity and import penetration on productivity growth. This suggests that our empirical results are not entirely in line with Hung *et al* (2004). We could not find significant role of relative import price in productivity growth performance. On the other hand, import penetration was found to have better explanation of productivity growth in our case. However, similar to Hung *et* al (2004), we find weak evidence of the impact of exports on productivity growth in Indian industries. There are studies, which assessed some aspects of trade on productivity growth in Indian manufacturing. Contrary to Das (1998), we find some evidence of positive impact of import penetration in manufacturing productivity growth. This conflicting result can be attributed to the differences in period and methodology of the two studies. Some recent studies, like Topalova and Khandelwal (2011) and Sharma (2011) have found significant role of import of intermediate goods on firm productivity in India.

7 Summary and Conclusion

In this paper, we looked at the impact of trade on productivity growth in the Indian organised manufacturing sector. We argued that trade-productivity linkage operates through economies of scale effect, competition effect, spillover effect and reallocation effects. In order to capture these effects, we included several trade related variables such as relative import price ratio, import penetration ratio and export intensity. We examined the impact of trade on productivity growth (TFP and Labour productivity) using random effect estimation methods of balanced panel data for the period 1981-2007. The empirical analysis was conducted for 62 manufacturing industries at 4-digit NIC 2004 classification.

The results of panel regressions indicate that trade had a significant role in productivity growth of Indian manufacturing sector. Trade induced channels like reallocation effect and economies of scale effects operate through increased imports in the domestic manufacturing sector. We further noted that the impact of import penetration on productivity occurs only after a year. The same holds true for relative import prices. This suggests that in the short period, the negative diseconomies of scale dominate but over time, the positive effect of reallocation and the competition effect force domestic producers to improve productivity. In the case of exports, we do not find any immediate effect of export intensity on TFP but we find that the impact of exports on productivity occur only after 2 year. This suggests that the positive effect of reallocation channel, spillover channel and economies of scale channel associated with export is rather weak. In the labour productivity model, we could not find any contemporaneous effect of a reduction in import price and a rise in import intensity on labour productivity. Instead, we find that competition pressure, reallocation of resources and economies of scale associated with increased imports affect labour productivity after 1-year. The analysis reveal that the impact of international trade on productivity growth in the Indian manufacturing sector is not static but dynamic in nature.

APPENDIX

Table A1
Detailed description of the selected industries

Sl No	4 digit NIC 2004	Product Description
1	1511	Meat Prepared and Preserved
2	1520	Dairy Products
3	1513	Canned and Preserved fruits and Vegetables
4	1512	Canned and Preserved crustacean and similar fish
5	1531	Milled Grain
6	1541	Bakery Products
7	1542	Refined Sugar + Indigenous Sugar
8	1543	Coca Products and Sugar Confectionery
9	1514	Manufacture of vegetable and animal oils and fats
10	1554	Manufacture of soft drinks; production of mineral waters
11	1533	Prepared Animal and Bird Feed
12	1532	Starch
13	1544+1549	Manufacture of macaroni, noodles, conscious + Other food products
14	1711	Preparation and spinning of textile fiber including weaving of textiles.
15	1721	Made Up textiles except apparel + Waterproof Textiles
16	1722	Manufacture of carpet and rugs
17	1729	Embroidery and Zari articles and Ornamental trimmings
18	1810	Textile Garments and clothing accessories
19	1730	Knitted or crocheted textile products
20	1723	Thread, Cordage, ropes, twines, nets, etc
21	2101	Pulp, Paper and Paperboard, Newsprint
22	2102	Containers, Boxes etc of Paper and Paperboard
23	2109	Paper and Paperboard articles and Pulp articles + Special Purpose Paper
24	2212	Newspaper
25	2211+2219+2222	Periodicals, Books, Journals etc, Block Making, Binding etc
26	2221	Currency Notes, Stamps, Stamp Papers etc + Other Printed material
27	1911	Finished Leather
28	2411	Industrial, Organic and Inorganic Chemicals
29	2412+2421	Fertilizers and Pesticides
30	2413	Plastic in primary forms, Synthetic rubber
31	2422	Paints, Varnishes, Dyes and artists colours and Ink
32	2423	Drugs, Medicines and Allied Pharmaceutical Products
33	2424	Perfumes, Cosmetics, Soaps, Toiletries etc
34	2511	Tyres and Tubes
35	2519	Rubber Products n.e.c
36	2520	Plastic Products n.e.c
37	2310	Cole Oven Products + Coal and Coal Tar Products
38	2320	Refined Petroleum and Products
39	2429	Matches + Chemical Products n.e.c

Table A1 (Concluded)

40	2710	Iron and Steel in Primary/Semi-Finished Forms + Ferro Alloys
41	2720	Manufacture of basic precious and non-ferrous metals
42	2921	Agricultural Machinery and Parts
43	2924	Mining and Construction Machinery, equipment and Parts
44	2813+2911	Primary Movers, Steam Generating Plants and Nuclear reactors
45	2925+2926	Food and Textile Machinery
46	2912+2913+ 2914+2915	General Purpose Non-Electrical Machinery, Equipment & Accessories
47	2922	Machine Tools, Accessories and Parts
48	3000	Manufacture of office, accounting and computing machinery
49	2919+2923+2927+2929	Industrial Machinery (Other than Food and Textile Machinery) + Special Purpose Machinery, Equipment, components and Accessories (Sewing, Knitting, Weighting, Washing, Distilling, Filtering etc., Machinery, arms and armaments
50	3110+3120	Electrical Machinery and Parts
51	3130	Insulated Wires and Cables
52	3140	Accumulators, Primary Cells, and Primary Batteries
53	3230	Manufacture of television and radio receivers, sound
54	3210	Electronic Valves and Tubes
55	3190	Radiographic X-ray apparatus, X-ray tubes and Parts and Electrical equipment n.e.c
56	3511+3512	Ships and Boats
57	3520	Locomotives and Parts, railway/tramway coaches
58	3410+3420+3430	Heavy Motor Vehicles, Motor Cars and other transport equipment
59	3591	Motor Cycles, Scooters, three wheelers and parts
60	3592	Bicycles, Cycle rickshaws and Parts
61	3530	Aircrafts, Spacecrafts and Parts
62	3599	Bullock Carts, Push Carts and Hand Carts

Source: Author's compilation based on National Industrial classification (CSO).

Table A2
Concordance between Industrial production and trade classification (1988-2007)
NIC 2004 (ISIC Rev3) to SITC rev3

NIC 2004 (or ISIC rev3)	SITC rev3
1511	01111-12, 01121-22, 01211-13, 01221-22, 01231-35, 0124, 01251-56, 01291, 01299, 01611-12, 01619, 01681, 01689, 0171-76, 0179, 08141, 21111-13, 2112, 2114, 2116-17, 26819, 4112, 41131-32
1520	02211-13, 02221-24, 02231-33, 02241, 02249, 0230, 0241-43, 02491, 02499, 06191, 59221
1513	05461, 05469, 0547, 05485, 05612, 05613, 05619, 05641-42, 05661, 05669, 05671-74, 05676-77, 05679, 05752, 05799, 0581, 05821-22, 05831-32, 05839, 05892-97, 0591-93, 05991-96
1512	03419, 03421-23, 03424-29, 0344, 03451, 03455, 03511, 03512-13, 03521-22, 03529, 0353-55, 03611, 03619, 03637, 03639, 03711-13, 03714-17, 03721-22, 08142, 29196
1531	0422, 04231-32, 0461-62, 04711, 04719, 04721-22, 04729, 04811-15, 05646-48
1541	04841-42, 04849
1542	06111, 06112, 06121, 06129, 06151, 06159, 06192
1543	0621, 06221, 06229, 0722, 07231-32, 0724, 0731-33, 0739
1514	08131-39, 09101, 09109, 2239, 2632, 41111-13, 41133, 41139, 42111, 42119, 42121, 42129, 42131, 42139, 42141-42, 42149, 42151, 42159, 42171, 42179, 4218, 42211, 42219, 42221, 42229, 42231, 42239, 42241, 42249, 4225, 42291, 42299, 43121-22, 43133, 43141
1554	0986, 09893-94, 09899, 11101-02
1533	08195, 08199
1532	05645, 06193, 06194, 06195-96, 06199, 42161-69, 59211-12, 59213-14, 59215-16, 59217, 59226
1544+1549	0483, 09891 + 02521-22, 0253, 07112, 0712, 07131-32, 07133, 07411, 07413, 07432, 09811-14, 09841-44, 09849, 0985
1711	2613, 26149, 2634, 2649, 26512-13, 26529, 26549, 26559, 26579, 26589, 26671-73, 26679, 26713, 26821, 26829, 26863, 26871, 26873, 26877, 41134, 41135, 65112-19, 65121-22, 65131-34, 65141-44, 65161, 65169, 65171, 65176, 65181-87, 65192-94, 65196, 65197, 65199, 65211-15, 65221-26, 65231-34, 65241-45, 65251-54, 65261-65, 65291-98, 65311-19, 65321, 65325, 65329, 65331-34, 65341-43, 65351-52, 65359, 6536, 65381-83, 65389, 65391, 65393, 65411, 65413, 65419, 65421-22, 65431-35, 65441-42, 6545, 65492-97
1721	65811-13, 65819, 65821-24, 65829, 65831-33, 65839, 65841-48, 65851-52, 65859, 65891-93, 65899, 82127, 82129, 89996
1722	65921, 65929, 6593, 65941-43, 65949, 65951-52, 65959, 65961, 65969
1729	65191, 65611-14, 65621, 65629, 65631-32, 65641-43, 65651, 65659, 65711-12, 65719, 6572, 65731-34, 6574, 65771-73, 65781, 65785, 65789, 65791-93
1810	65761-62, 84111-12, 84119, 84121-23, 8413-14, 84151, 84159, 84161-62, 84169, 84211, 84219, 84221-24, 8426-27, 84281-82, 84289, 8431, 84321-24, 84371, 84379, 84381-82, 84389, 8441, 84421-22, 84424-26, 8447, 84481-83, 84489, 84511-12, 84521-24, 84551-52, 84561-64, 84581, 84587, 84589, 84591-92, 84599, 84611-14, 84619, 84691-94, 84699, 84811-13, 84819, 84841-43, 84848-49
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1723	65751-52, 65759
2101	2512-13 25141-42, 25151-52, 25161-62, 25191-92, 6411, 64121-27, 64129, 64131-34, 64141-42, 64146-48, 64151-59, 64161-63, 64169, 64171-79, 64191-92
2102	64164, 64211-13, 64214-16
2109	64193-94, 64221-23, 64241-45, 64248, 64291, 64293-95, 65735, 65911, 89281
2212	89221, 89229
2211+2219+2222	89212-16, 89219, 89285 + 89241-42, 89283-84, 89287 + 72635
2221	64231-35, 64239, 89286, 89289
1911	6112-13, 61141-42, 61151-52, 61161-62, 61171-72, 61179, 61181, 61183
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2413	23211-19, 57111- 12, 5719, 57211, 57219, 57291-92, 57299, 57311-13, 57391-94, 57399, 57411, 57419, 5742, 57431-34, 57439, 57511-13, 57519, 57521, 57529, 57531, 57539, 57541-45, 57551-54, 57559, 57591-97
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Table A2 (Concluded)

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2519	23221, 62111-12, 62119, 62129, 62131-33, 62141-45, 62911, 62919, 62929, 62991-92, 62999, 65733, 84822, 84829
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2925+2926	72138-39, 72191, 72198, 72711, 72719, 72721-22, 72729, 72843, 72853, 74137, 74184, 74187, 74351 + 72433, 72435, 72439, 72441-43, 72449, 72451-55, 72461, 72467, 72468, 72471-74, 72481, 72483, 72485, 72488, 72491-92
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3110+3120	7161-62, 71631-32, 7164, 71651-52, 7169, 77111, 77119, 77121, 77123, 77125, 77129 + 77241-45, 77249, 77251-55, 77257, 77258, 77259, 77261-62, 77281-82
3130	77311-15, 77317-18
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3190	77313, 77324, 77329, 77831, 77833-35, 77871, 77878-79, 77881-86, 77889
3511+3512	79322, 79324, 79326-2729, 79351-55, 79359, 7937, 79391, 79399 + 79311-12, 79319
3520	79111, 79115, 79121, 79129, 7916-17, 79181-82, 79191, 79199
3410+3420+ 3430	71321-23, 7811-12, 78219, 78221, 78223, 78225, 78227, 78229, 78311, 78319, 7832, 7841 + 78421, 78425, 7861, 78622, 78629, 7863, 78683, 78689 + 71391-92, 78431-36, 78439
3591	78511, 78513, 78515-17, 78519, 78535
3592	7852, 78531, 78536-37
3530	71311, 71319, 71441, 71449, 71481, 71491, 79211, 79215, 7922-25, 79281-83, 79291, 79293, 79295, 79297
3599	78685

Source: Author's compilation with the help of correspondence table compiled by United Nation Statistical Division (UNSD)

Table A3
Distribution of manufacturing trade of India by technology classification: Share of 4-digit industrial groups in total trade (%) 1980-07

4-digit (NIC 2004)	1980-90		1991-00		2001-07		1980-07	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
High Technology Industries (HT)								
2423	72.5 (3.2)	23.9 (2.0)	69.8 (4.2)	21.9 (2.0)	71.7 (4.9)	13.3 (1.8)	71.3 (4.0)	20.5 (2.0)
3000	12.7 (0.7)	18.0 (1.6)	13.9 (0.8)	26.5 (2.5)	11.8 (0.8)	36.7 (4.9)	12.9 (0.8)	25.7 (2.8)
3230	4.0 (0.2)	9.5 (0.9)	6.2 (0.4)	8.8 (0.8)	4.9 (0.3)	12.2 (1.6)	5.0 (0.3)	9.9 (1.0)
3210	7.5 (0.4)	20.7 (2.0)	8.4 (0.5)	22.8 (2.1)	8.2 (0.6)	16.0 (2.1)	8.0 (0.5)	20.3 (2.1)
3530	3.3 (0.1)	27.9 (2.6)	1.7 (0.1)	20.0 (2.1)	3.3 (0.2)	21.7 (3.0)	2.7 (0.1)	23.5 (2.5)
Total Share of HT	**4.6**	**9.0**	**6.1**	**9.6**	**6.9**	**13.5**	**5.7**	**10.4**
Medium High Technology industries (MHT)								
2411	11.9 (2.0)	19.3 (8.8)	33.4 (6.3)	28.4 (12.1)	32.3 (7.7)	27.6 (10.4)	24.7 (5.0)	24.6 (10.4)
2412+2421	2.0 (0.3)	15.3(6.5)	4.5 (0.8)	12.3 (5.3)	3.9 (0.9)	8.0 (3.0)	3.4 (0.7)	12.4 (5.2)
2413	0.3(0.0)	6.5(3.1)	2.2(0.4)	8.1 (3.5)	7.8(1.9)	7.3 (2.8)	2.8 (0.6)	7.3 (3.2)
2422	7.7 (1.2)	0.6 (0.3)	0.5 (0.1)	0.5 (0.2)	0.8 (0.2)	0.7 (0.3)	3.4 (0.6)	0.6 (0.2)
2424	9.0 (1.6)	0.3 (0.2)	4.2 (0.8)	0.8 (0.3)	2.3 (0.5)	0.9 (0.4)	5.6 (1.0)	0.6 (0.3)
2429	3.5 (0.6)	2.6(1.3)	4.9 (0.9)	4.9 (2.1)	4.2 (1.0)	5.5 (2.1)	4.2 (0.8)	4.2 (1.8)
2921	0.7 (0.1)	0.2 (0.1)	0.5 (0.1)	0.2 (0.1)	0.9 (0.2)	0.2 (0.1)	0.7 (0.1)	0.2 (0.1)
2924	5.1 (0.8)	4.6(2.2)	0.8 (0.1)	2.0 (0.9)	1.4 (0.3)	3.6 (1.4)	2.6 (0.5)	3.4 (1.5)
2813+2911	7.1 (1.2)	3.8(1.7)	2.3(0.4)	2.2 (0.9)	1.5(0.4)	1.7 (0.6)	4.0 (0.7)	2.7 (1.2)
2925+2926	6.1(1.0)	8.9 (4.6)	3.1(0.6)	6.0 (2.6)	1.6 (0.4)	5.3 (2.0)	3.9 (0.7)	6.9 (3.2)
2912+2913+ 2914+2915	5.4 (0.9)	11.5(5.3)	4.8 (0.9)	8.6 (3.7)	6.6 (1.6)	9.1 (3.4)	5.5 (1.1)	9.9 (4.3)
2922	4.4 (0.7)	4.0 (1.8)	1.9 (0.4)	3.7 (1.6)	1.6 (0.4)	3.7 (1.4)	2.8 (0.5)	3.8 (1.6)
2919+2923+ 2927+2929	4.7 (0.8)	11.1 (5.5)	5.1 (1.0)	9.2 (3.9)	6.4 (1.5)	9.8 (3.7)	5.3 (1.0)	10.1 (4.5)
3110+3120	3.8 (0.6)	5.6 (2.7)	4.1 (0.8)	4.5 (1.9)	6.0 (1.4)	6.5 (2.5)	4.5 (0.9)	5.4 (2.4)
3130	2.8 (0.5)	0.5 (0.3)	0.6 (0.1)	0.6 (0.3)	0.9 (0.2)	1.5 (0.6)	1.6 (0.3)	0.8 (0.3)
3140	2.8 (0.4)	0.3 (0.1)	0.6 (0.1)	0.3 (0.1)	0.5 (0.1)	0.6 (0.2)	1.5 (0.2)	0.4 (0.1)
3190	0.9 (0.2)	0.8 (0.4)	3.1 (0.6)	1.9(0.8)	3.1 (0.7)	2.3 (0.9)	2.3 (0.5)	1.5 (0.6)
3520	1.4 (0.2)	1.2 (0.5)	0.3 (0.1)	0.7 (0.3)	0.2 (0.0)	0.4 (0.2)	0.7 (0.1)	0.8 (0.3)
3410+3420+3430	11.2 (1.9)	1.8 (0.8)	16.2 (3.0)	5.1 (2.2)	14.5 (3.5)	5.1 (1.9)	13.8 (2.7)	3.8 (1.6)
3591	4.7 (0.7)	0.6 (0.3)	2.0 (0.4)	0.1 (0.1)	1.8 (0.4)	0.1 (0.0)	3.0 (0.5)	0.3 (0.2)
3592	4.4 (0.7)	0.4 (0.2)	4.9 (0.9)	0.1 (0.0)	1.8 (0.4)	0.2 (0.1)	3.9 (0.7)	0.3 (0.1)
3599	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Total Share of MHT	**16.4**	**6.7**	**18.7**	**43.0**	**23.8**	**37.8**	**19.1**	**43.2**
Medium Low Technology industries (MLT)								
2511	10.0 (0.6)	0.2 (0.0)	10.0 (1.1)	0.2 (0.1)	3.7 (0.9)	0.3 (0.1)	8.4 (0.9)	0.2 (0.1)
2519	8.2 (0.4)	2.1 (0.5)	3.4 (0.4)	1.1 (0.4)	1.9 (0.5)	1.2 (0.4)	4.9 (0.4)	1.5 (0.5)
2520	10.5 (0.8)	2.0 (0.5)	11.9 (1.4)	1.8 (0.7)	5.5 (1.3)	2.6 (0.9)	9.7 (1.1)	2.1 (0.7)
2310	0.0 (0.0)	0.5 (0.1)	0.1 (0.0)	1.4 (0.5)	0.1 (0.0)	2.6 (1.0)	0.0 (0.0)	1.3 (0.5)
2320	54.5 (4.5)	61.0 (17.9)	20.9 (2.6)	45.9 (16.7)	48.6 (13.8)	20.0 (7.6)	41.0 (6.1)	45.3 (14.9)
2710	7.2 (0.8)	13.5 (3.6)	39.1 (4.5)	15.3 (5.6)	26.9 (7.1)	13.0 (4.9)	23.5 (3.7)	14.0 (4.6)
2720	8.6 (0.9)	17.9 (4.6)	13.0 (1.5)	31.9 (12.0)	11.2 (3.1)	53.8 (20.0)	10.8 (1.7)	31.9 (11.1)
3511+3512	1.0 (0.1)	2.8 (0.8)	1.6 (0.2)	2.4 (0.9)	2.1 (0.7)	6.7 (2.5)	1.5 (0.2)	3.7 (1.3)
Total Share of MLT	**8.0**	**28.0**	**11.6**	**36.9**	**27.3**	**37.5**	**14.1**	**33.6**

Low Technology Industries (LT)								
1511	1.3 (0.9)	1.5 (0.2)	1.4 (0.9)	5.7 (0.6)	2.3 (0.9)	2.8 (0.3)	1.6 (0.9)	3.3 (0.3)
1520	0.0 (0.0)	3.9 (0.7)	0.1 (0.1)	1.0 (0.1)	0.5 (0.2)	0.5 (0.1)	0.2 (0.1)	2.0 (0.3)
1513	1.2 (0.8)	0.9 (0.1)	0.8 (0.5)	0.1 (0.0)	1.0 (0.4)	0.4 (0.0)	1.0 (0.6)	0.5 (0.1)
1512	8.3 (5.9)	0.1 (0.0)	8.1 (5.2)	0.3 (0.0)	6.5 (2.8)	0.6 (0.1)	7.8 (4.9)	0.3 (0.0)
1531	5.4 (3.9)	4.6 (0.7)	6.4 (4.1)	2.0 (0.2)	6.4 (2.6)	0.3 (0.0)	6.0 (3.6)	2.6 (0.3)
1541	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.1(0.0)	0.2 (0.1)	0.1 (0.0)	0.1 (0.0)	0.0 (0.0)
1542	1.2 (0.9)	6.8 (1.1)	0.8 (0.5)	3.1 (0.4)	1.8 (0.7)	1.1 (0.1)	1.2 (0.7)	4.0 (0.6)
1543	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.2 (0.0)	0.1 (0.0)	0.3 (0.0)	0.1 (0.0)	0.1 (0.0)
1514	4.8 (3.4)	40.4 (7.1)	6.7 (4.2)	28.5 (3.3)	4.8 (1.9)	39.9 (4.6)	5.5 (3.3)	36.0 (5.1)
1554	0.0 (0.0)	0.2 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.2 (0.0)	0.0 (0.0)	0.1 (0.0)
1533	0.0 (0.0)	0.0 (0.0)	0.1 (0.0)	0.9 (0.1)	0.1 (0.0)	0.7 (0.1)	0.1 (0.0)	0.5 (0.1)
218	0.0 (0.0)	0.5 (0.1)	0.1 (0.0)	0.1 (0.0)	0.1 (0.0)	0.2 (0.0)	0.0 (0.0)	0.3 (0.0)
1532	15.3 (11.2)	2.3 (0.4)	2.4 (1.5)	3.5 (0.3)	1.6 (0.7)	0.9 (0.1)	7.3 (5.1)	2.4 (0.3)
1544+1549	14.3 (10.0)	8.1 (1.2)	22.3 (14.2)	15.1 (1.5)	20.3 (8.7)	15.2 (1.7)	18.7 (11.2)	12.4 (1.4)
1711	5.6 (4.0)	0.4 (0.1)	5.6 (3.5)	0.3 (0.0)	8.5 (3.5)	0.7 (0.1)	6.3 (3.7)	0.4 (0.1)
1721	7.0 (4.9)	0.1 (0.0)	5.6 (3.5)	0.1 (0.0)	4.1 (1.7)	0.4 (0.0)	5.7 (3.6)	0.2 (0.0)
1722	0.4 (0.3)	0.9 (0.1)	0.7(0.5)	4.7 (0.5)	0.9 (0.4)	6.1 (0.7)	0.6 (0.4)	3.6 (0.4)
1729	21.7 (15.1)	0.0 (0.0)	31.7 (20.1)	0.2 (0.0)	29.6 (12.5)	0.8 (0.1)	27. 2 (16.2)	0.3 (0.0)
1810	3.9 (2.8)	0.3 (0.0)	3.4 (2.2)	0.6 (0.1)	6.0 (2.5)	1.3(0.1)	4.3 (2.5)	0.7 (0.1)
1723	0.1 (0.1)	0.8 (0.1)	0.2 (0.1)	0.3 (0.0)	0.2 (0.1)	0.3 (0.0)	0.2 (0.1)	0.5 (0.1)
2101	0.1 (0.0)	18.9 (2.9)	0.4 (0.3)	23.4 (2.3)	0.9 (0.4)	15.9 (1.7)	0.4 (0.2)	19.7 (2.4)
2102	0.0 (0.0)	0.2 (0.0)	0.0 (0.0)	0.6 (0.1)	0.1 (0.0)	0.2 (0.0)	0.1 (0.0)	0.3 (0.0)
2109	0.1 (0.0)	4.7 (0.7)	0.1 (0.1)	1.0 (0.1)	0.3 (0.1)	1.2 (0.1)	0.1 (0.1)	2.5 (0.4)
2212	0.1 (0.1)	0.2 (0.0)	0.1 (0.0)	0.3 (0.0)	0.1 (0.0)	0.1 (0.0)	0.1 (0.1)	0.2 (0.0)
2211+2219+2222	0.3 (0.2)	2.8 (0.4)	0.2 (0.1)	3.5 (0.4)	0.5 (0.2)	6.0 (0.6)	0.3 (0.2)	3.9 (0.5)
2221	0.0 (0.0)	0.2 (0.0)	0.1 (0.0)	0.1 (0.0)	0.2 (0.1)	0.1 (0.0)	0.1 (0.0)	0.1 (0.0)
1911	8.8 (6.3)	1.1 (0.1)	2.8 (1.8)	4.6 (0.5)	2.8 (1.2)	3.7(0.4)	5.1 (3.4)	3.0(0.3)
Total Share of LT	**71.0**	**16.2**	**63.6**	**10.5**	**42.0**	**11.2**	**61.1**	**12.1**

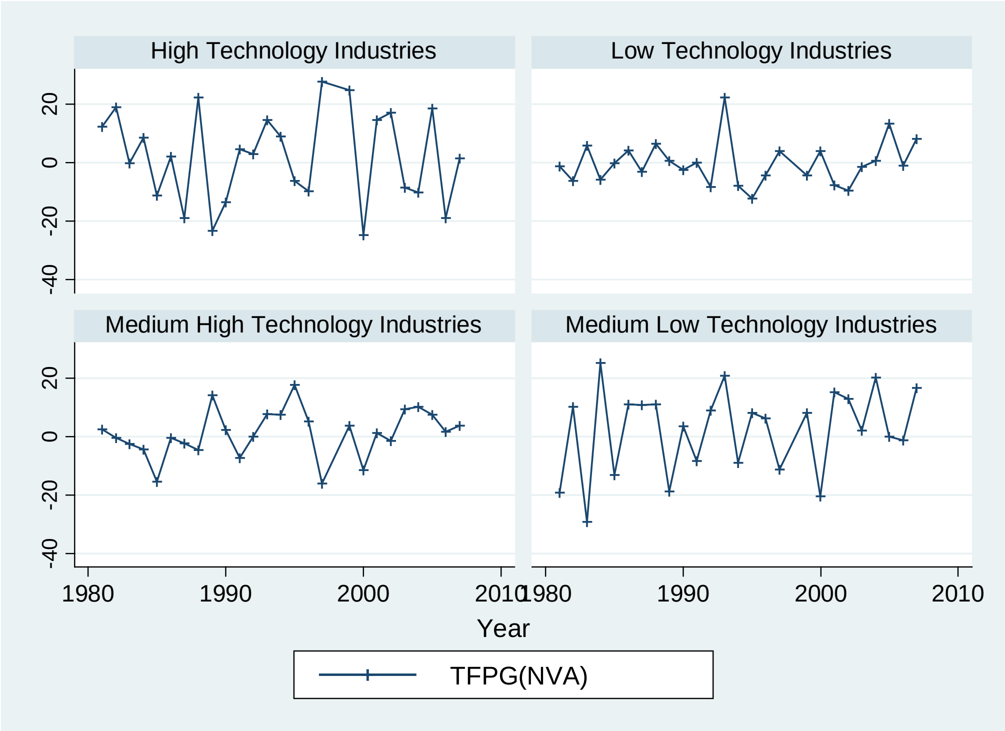
Note: **(i)** Figures adjacent to the values in brackets are share of each product group in respective technology intensive category **(ii)** Figure in brackets correspond to the share of individual products in aggregate manufacturing exports/imports (62 four-digit industries), **(iii)** HT: High technology Industry, MHT: Medium high Technology industry, MLT: Medium low technology industry, LT: Low technology industry. Technology classification is taken from OECD (2011).

Source: Author's calculation based on COMTRADE database, accessed from WITS.

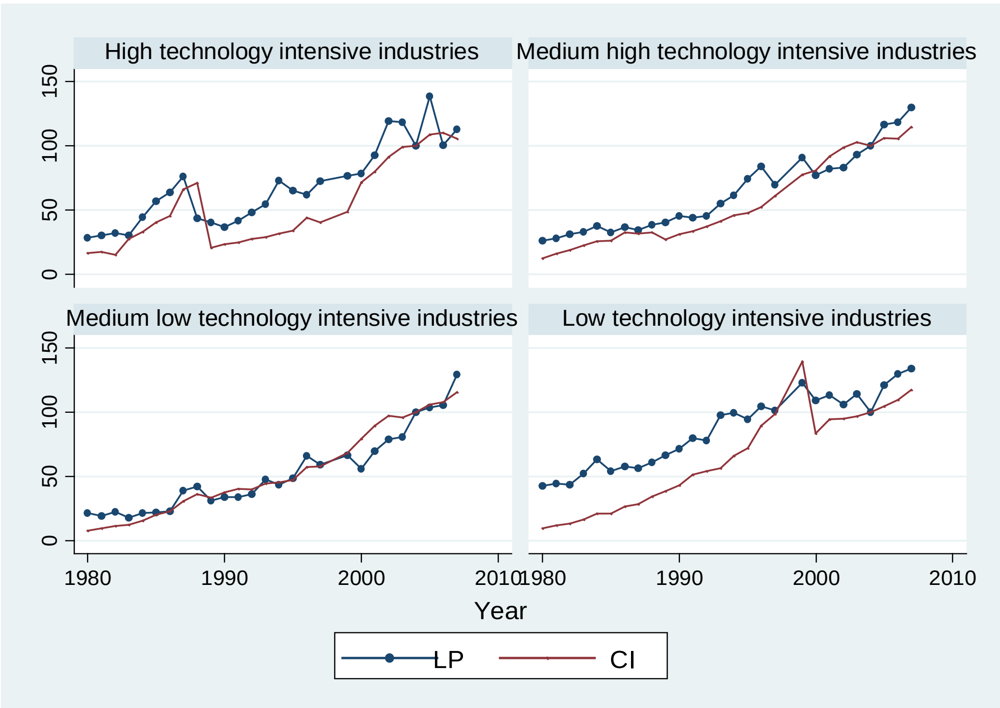
Figure A1

Trend in Productivity in 4-digit industries: By Technology intensity (% per annum) 1980-2007

(a) Total Factor Productivity



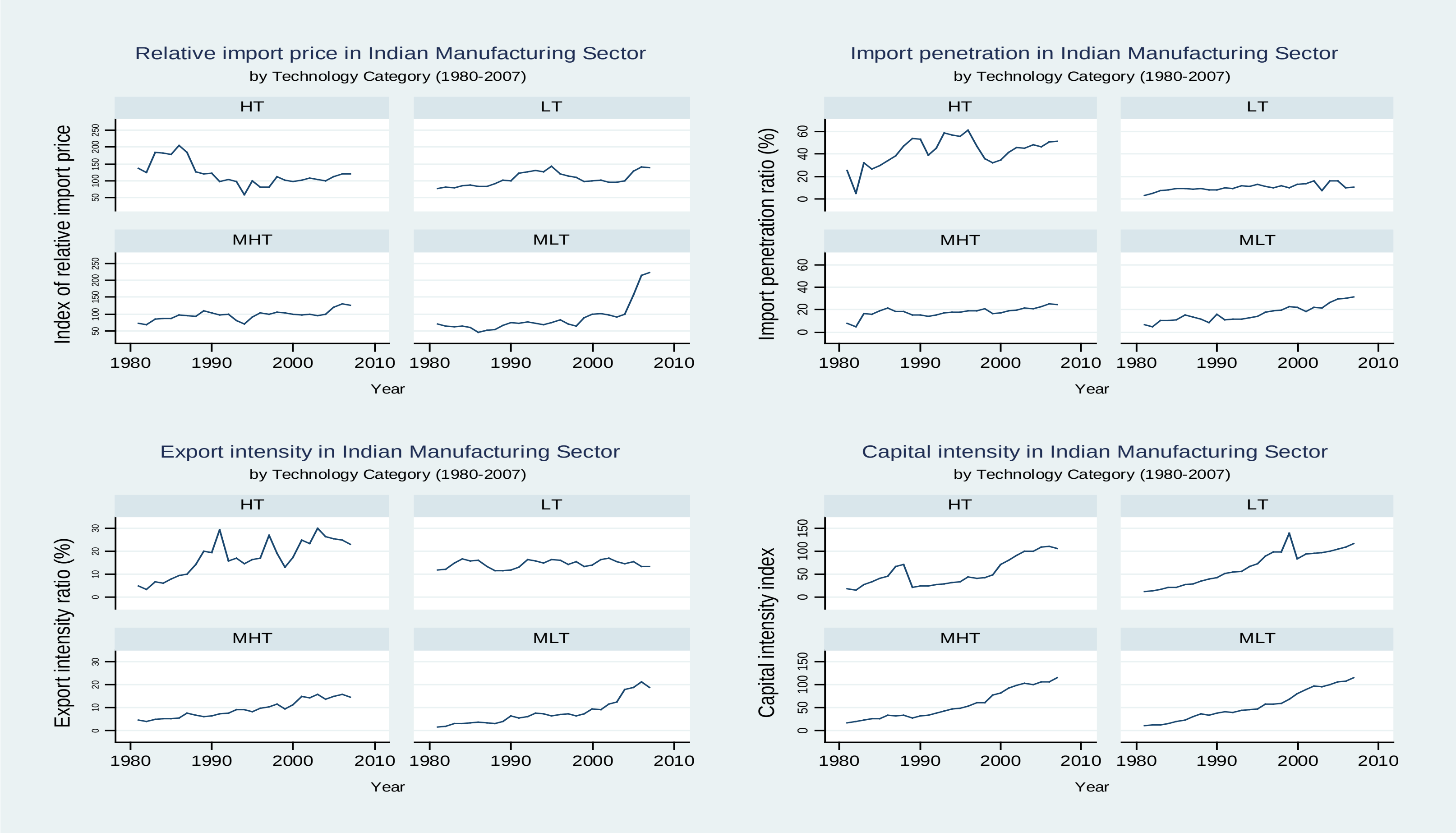
(b) Labour productivity and capital intensity Indices



Note: TFPG (NVA) Total factor productivity growth rates based on Net Value Added. LP: Labour productivity, CI: Capital Intensity

Source: Author's calculation based on data collected from ASI

Figure A2
Relative import price, Import penetration, Export intensity and Capital-intensity in Indian manufacturing sector: By technology intensity category (1980-2007)



Note: Import penetration ratio and export intensity are percentage shares according to different technology category. Relative import prices and capital intensity are level values expressed in an index form. HT: High technology intensive category, MHT: Medium high technology intensive category, MLT: Medium low technology intensive category, LT: Low technology intensive category.

Source: Author's calculation based on ASI, UN COMTRADE, WPI series from Ministry of Economic Advisor, Handbook of Statistics on Indian Economy, RBI. Technology classification is taken from OECD (2011).

Table A4
Summary statistics: by 4Digit NIC 2004

Variables	Mean	Std. Dev.	Observations
TFPVA	0.4	33.0	1674
TFPGO	-0.1	19.3	
LPVA	12.4	41.7	
RP	101.9	48.3	
IMP	16.1	25.6	
EXI	12.0	15.1	
CI	60.0	50.2	
CU	42.3	22.0	

Note: 4-digit industries refers to 62 product groups based on NIC 2004 classification. TFPVA= TFP derived by value added framework, TFPGO= TFP based on gross output framework, LPVA= labour productivity based on value added, RP= Relative import price index, IMP=Import penetration ratio (%), EXI=Export intensity (%), CI=Capital intensity index, CU= Capacity utlisation rate (%).

Table A5
Panel Regression of productivity growth in Indian manufacturing sector
(4-digit industries sample) 1980-2007

Dependent variable TFPG based on gross output framework $\Delta \ln P\ (GO)$

Explanatory Variables	**RANDOM EFFECTS**		
	(i) No Lag	(ii) 1-year Lag	(iii) 2-Year Lag
ΔRP	0.049*** (0.017)	-0.025* (0.013)	0.003 (0.012)
ΔIMP	-0.121** (0.060)	0.051** (0.025)	0.029 (0.030)
ΔEXI	-0.302** (0.103)	0.141* (0.076)	0.051 (0.091)
ΔCI	-0.022 (0.023)	-0.023 (0.024)	-0.023 (0.025)
ΔCU	0.219*** (0.070)	0.230*** (0.075)	0.223** (0.078)
constant	0.497 (0.546)	0.450 (0.567)	0.583 (0.558)
R^2	0.06	0.03	0.03
Wald test	38.77 (0.0000)***	21.89 (0.0006)***	13.11 (0.0223)
Hausman	1.49 (0.9142)	1.02 (0.9608)	1.03 (0.9600)
No of observations	1674	1612	1550
No of industries	62	62	62

Notes: (1) Contemporaneous coefficient estimates on ΔCU and ΔCI for all columns. In column (b), coefficient estimates are for 1-year lag; in column (c), coefficient estimates are for 2-year lag. (2) The Huber-White robust standard errors are given in parentheses under estimated coefficients (3) p-values are given in parentheses under chi^2 – statistics for Wald test statistic. (4) Hausman statistic is asymptotically χ^2 distributed with p-values in brackets. (5) * significant at 0.01 level for a two-tailed test, ** at 0.05 level for a two-tailed test, *** significant at 0.1 level for a two-tailed test. (6) RP, relative import price; IMP, import penetration; EXI, exports share in total output; CI, capital intensity in production; and CU, capacity utilization.

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