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India's Manufacturing Exports Dynamics: An Analysis of Technology Intensity Transition

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Abstract

In a globally competitive scenario, countries relying significantly on exports of primary products face constraints in the long run development process. Negative trends in the secular terms of trade, uncertainty arising from price variability and the consequent fluctuating export earnings, difficulties in achieving economic diversification have all proven to be detrimental for such countries amid development challenges and low incomes. With the development process, there is a shift from natural resource based and low technology intensive exports to medium and high technology intensive exports. The paper seeks to capture the shift in the technology intensity of India's manufacturing exports in the post liberalized period. The study is based on the data extracted from UNCOMTRADE-WITS database (SITC REV-3). Further, OECD classification of manufacturing industries on technology intensity is taken into consideration. Using trade indicators (such as RCA) and regression model, the analysis reveals a steady, albeit slow shift from low technology intensive exports to medium-low technology intensive exports in India. Though improvement was marked for the medium-high technology intensive exports, dominance of low technology intensive exports still persists. The major factors for the persistence of low technology intensive exports are low level of R&D in manufacturing sector, lack of skilled personnel, relatively low level of FDI and competitiveness. However, in case of high technology intensive manufacturing exports, India still lags behind. The study highlights incentivizing high technology intensive export as a concern for the policy makers.

Keywords: *Technology Intensity, Manufacturing, Exports, India*

JEL Classification Codes: *O14; L60; F14; R58*

India's Manufacturing Exports Dynamics: An Analysis of Technology Intensity Transition

I. Introduction

The patterns of economic development are associated with structural changes in exports and expansion of export diversification worldwide (Samen 2010). In a globally competitive scenario, countries completely relying on exports of primary products face constraints in the long run development process. Negative trends in the secular terms of trade, uncertainty arising from price variability and the consequent fluctuating export earnings, difficulties in achieving economic diversification have all proven to be detrimental for such countries amid development challenges and low incomes (Samen,2010; Lal,2000). Thus with the development process, there is a shift from natural resource based and low technology intensive exports to medium and high technology intensive exports. Given that India is progressive on the path of development, it is tempting to find out whether such trends are valid in Indian context as well.

In Indian context, the trade statistics do not simply support such an analysis. Exports of agriculture and allied products witnessed a decline in share from 19.4% in 1990-91 to 9.9% in 2010-11. This may be due to fact that, the self-reliance has been taken into consideration in the post-liberalized period. The share of manufacturing sector though increased during 1990-2000, but has been experiencing a declining trend since then. From being around 73% in 1990-91, the share of manufacturing exports rose steadily to almost 80% in 1999-2000. However the period from 2000 to 2011 marks a slowdown in its share in India's total merchandise exports. In 2010-11, manufacturing exports constitute 61.5% of India's merchandise exports. As noted by Kumar and Gupta (2008), lack of focused approach in identifying, sustaining and building the country's competitive advantage; concentration of exports in low value categories and relatively poor inflow of foreign direct investment (FDI) especially in export oriented industries are responsible for relatively weak performance of India's manufacturing exports.

Here, the questions are: If not the share of manufacturing exports, has the composition of manufacturing exports undergone a change? Is it that with a development India's manufacturing

exports are now more technology intensive? With these views, the paper seeks to capture the shift in the technology intensity of India's manufacturing exports in the post liberalized period.

The paper highlights the technology intensity of Indian manufacturing exports. The following sections focus on different aspects of the study. Section II summarizes the manufacturing sector of Indian economy with a special focus on innovation in the manufacturing sector through R&D expenditure by manufacturing firms in India. Section III provides overview on the manufacturing exports of India. Literature review of the selected papers to support the study is given in the section IV. Section V focus on the data and methodology of the study and section VI provides empirical analysis and results of the study. Conclusion of the study and suggested policy implications follows in section VII.

II. Overview of India's Manufacturing Sector

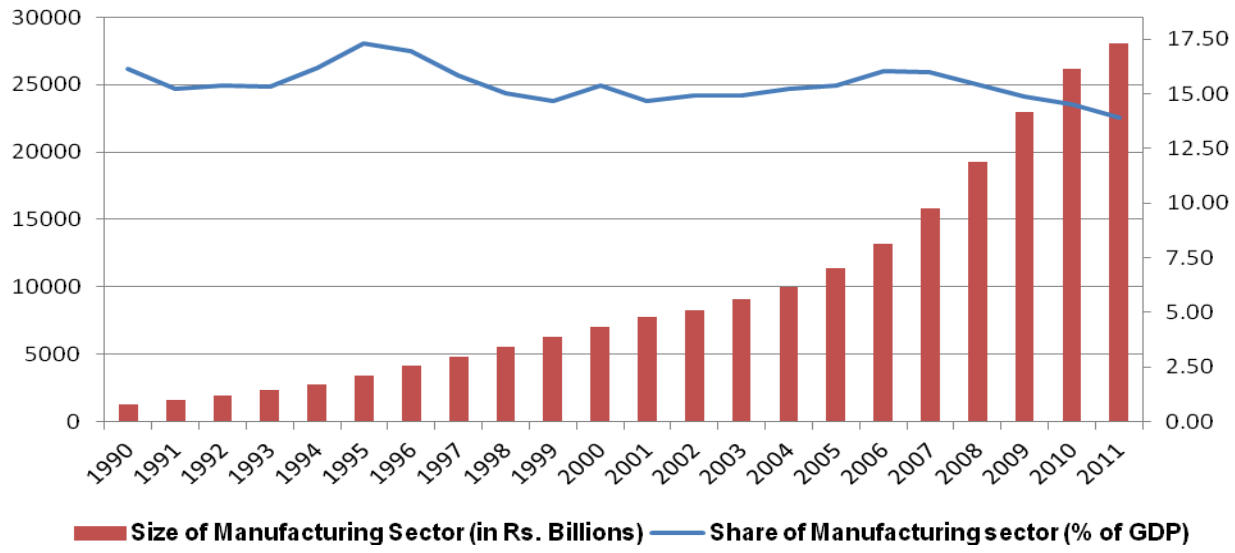
Manufacturing production and exports have been driving the rapid growth of many dynamic emerging economies. However, it has not contributed perceptibly to India's growth story; nor has it been up to the urgent task of shifting surplus work force from the agriculture sector[2]. Currently, India's manufacturing sector contributes about 16% to the GDP, and India's share in world manufacturing is only 1.8%. This is in stark contrast to China; where manufacturing contributes 34% to the GDP and is 13.7% of world manufacturing; up from 2.9% in 1991[3]. In fact contribution of manufacturing to GDP for 2010 is higher for countries like Thailand (36%), Malaysia (25%) and Indonesia (25%) than India (15%) (World Data Bank).[4]

The striking aspect of India's growth has been the dynamism of the service sector, while, in contrast, manufacturing has been less robust. In fact, Kochhar *et. al.* (2006) point out that the change in the share of manufacturing in GDP in India between 1980 and 2000 has been 2.5 percentage points (pps) lower than the average country at the same stage of development, while the change in service share was 10 pps higher than average.

[2] Ministry of Commerce & Industry, Report of the Working Group on 'Boosting India's Manufacturing Exports'
[3] Planning Commission, The Manufacturing Plan, http://planningcommission.nic.in/aboutus/committee/strgrp12/str_manu0304.pdf;
[4] http://databank.worldbank.org/ddp/home.do;

Manufacturing has not been the engine of growth for the Indian economy; it now needs to grow at a much faster rate to sustain in the external competitive environment. Further, the importance of manufacturing sector to the domestic and global economy is set to increase even further as a combination of supply-side advantages, policy initiatives, and private sector efforts set India on the path to a global manufacturing hub (IBEF 2012). Manufacturing is likely to contribute 25 percent to the GDP by 2025 as per the target set by the National Manufacturing Competitiveness Council (NMCC) report.[5] However, in order to attain a ~25% share of the GDP by 2025, manufacturing would need to grow at a rate of ~2-4% higher than the GDP[6]. Figure 1 shows the total market size of manufacturing sector in India and the percentage share of the sector in the GDP of the economy. The market size illustrates an increasing trend since 1990s. In absolute terms, manufacturing industries are expanding year by year from Rs. 1263 billion in 1990 to Rs. 28100 billion in 2011 and Rs. 28156 billion in 2012. In contrast, the contribution of manufacturing sector to the GDP of the economy is decreasing in percentage terms.

Figure 1. Size and Share of the Manufacturing Sector in India



Source: CMIE, Prowess Database; World Bank (2012)

[5] IBEF, India Manufacturing Sector Report, http://www.ibef.org/artdisplay.aspx?cat_id=84&art_id=31588;
[6] Planning Commission, The Manufacturing Plan, http://planningcommission.nic.in/aboutus/committee/strgrp12/str_manu0304.pdf;

Manufacturing sector serves the major part of the economy but register the decreasing share of growth. The lackluster growth of manufacturing can also be traced to the low technological depth of the Indian manufacturing sector. Therefore, the arena of concern is what all factors are responsible for the decreasing share? It could be costly raw materials, lack of innovation and proficient workforce of India. The paper undertakes the innovation as a one factor among others to depict the scenario of manufacturing sector in India.

"As manufacturing goes digital, it will change out of all recognition," says Paul Markillie.[7]

The above quote reflects how the innovation in manufacturing sector would help to sustain the economy at global level. Lack of depth in technology is one of the foremost issues affecting the growth of manufacturing sector in India. Most Indian manufacturing firms appear to be stuck at the basic or intermediate level of technological capabilities. In India manufacturing sector is losing its recognition and there is a need to invest more in R&D to make it competitive globally. India's R&D expenditure is 0.9% of GDP, whereas China, UK and Israel spent about 1.2%, 1.7% and 4.3% respectively[8] (Table 1). The relatively low spending on R&D is hampering India's potential to export advanced technology exports.

Table 1: Cross-country Comparison of Research and Development (2005)

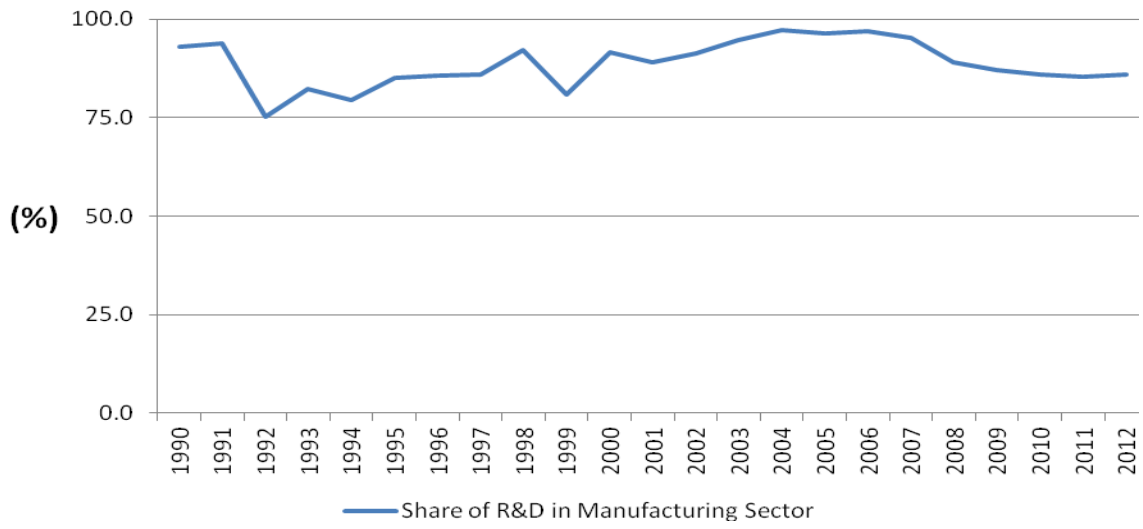
Country	Spending on R&D as percentage of GDP[9]
Argentina	0.42
Brazil	1.03
China	1.30
India	0.77
Indonesia	0.2
South Korea	2.5
Malaysia	0.7

Source: Kumar and Gupta (2008)

[7] The Economist (April 2012), A Third World Revolution, http://www.economist.com/node/21552901
[8] Planning Commission, The Manufacturing Plan, http://planningcommission.nic.in/aboutus/committee/strgrp12/str_manu0304.pdf
[9] Research and development is defined as current and capital expenditures (including overhead) on creative, systematic activity intended to increase the stock of knowledge. Included are fundamental and applied research and experimental development work leading to new devices, products or processes

Figure 2 shows the percentage share of R&D expenditure in manufacturing industries out of the total R&D expenditure by the companies in India. The figure overviews the trend since liberalization; the share always remains above 50% which implies that the manufacturing sector is the key area of R&D investment in India. However, the trend from 2008 depicts a decreasing share of R&D expenditure in the manufacturing sector.

Figure 2. Share of the Manufacturing Sector R&D in Total R&D expenditure of India



Source: CMIE, Prowess Database (2012)

Presently, the share of the R&D expenditure India in the public sector is about three fourth and only one fourth is in the private sector. This is in stark contrast to trends seen in China where private sector finances 70% of total R&D spending. Further, 65% of total R&D spending in the United States and approximately 75% of total R&D spending in Korea and Japan is also sponsored by the private sector[10].

Given the rather weak and public sector dominated R&D capacity, the private sector manufacturing firms may have to rely on more technological advances from their joint venture partners for product innovation, both for domestic and foreign markets. Greater attention to R&D and more openness to FDI may both be crucial for achieving the transition to mass

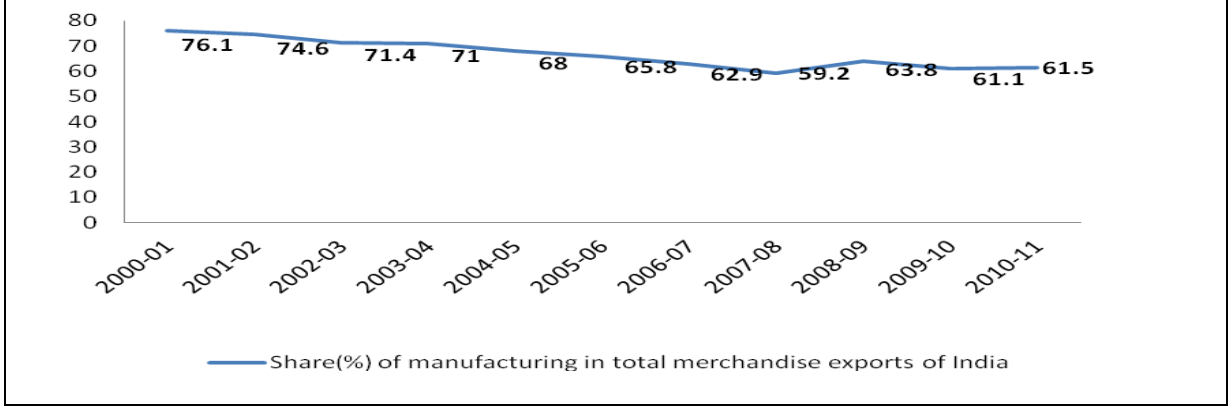
[10] Planning Commission, The Manufacturing Plan, http://planningcommission.nic.in/aboutus/committee/strgrp12/str_manu0304.pdf

manufacturing (Kumar and Gupta 2008). Creating conducive environments to increase business expenditure on R&D complemented by institutional measures around skill development, regulation and standardization need to be key areas of emphasis (Planning Commission 2012).

III. Overview of India's Manufacturing Exports

Manufacturing exports constitute the lion's share of merchandise exports of countries globally. Similarly, in case of India the dominance of manufacturing exports can be clearly visible. Manufacturing exports has always been a major contributor in India's total merchandise exports. However, as depicted in figure 3, its share declined substantially over the period 2000-01 to 2007-08 from above 76 per cent to 59 per cent. The share went up marginally thereafter, and is about to 61.5 per cent in 2010-11. The decline is largely attributable to the emergence of petroleum products (not covered under manufacturing) as one of the major items of merchandise exports for India in recent years. In contrast, in the case of Republic of China the share of manufacturing in total merchandise exports is 93 per cent (Planning Commission, 2012).

Figure 3. Share(%) of manufacturing in total merchandise exports of India



Source: DGCIS, 2012

Exports in the manufacturing sector have not been able to make a major impact on the global scale. This is evident from comparison of India's position with its peer emerging economy

China. While India's share in world manufacturing exports increased from 0.6 percent to 1.4 percent between 2000 and 2009, China tripled its contribution from 3.2 percent to over 10 percent in the same period (Planning Commission, 2012). India's share in global merchandise exports, in general, and manufacturing exports, in particular, though rising, has been not reflective of her economic strength and potential. The probable reasons may be the relatively slower rate of growth of manufacturing production, the low share of high tech exports, poor transport infrastructure and insufficient information with manufacturing about procedures and regulations of various countries affecting Indian exporters.

Recent Trends in Sectoral Composition of India's Manufacturing Exports

Manufacturing exports grew by a compound annual growth rate (CAGR) of 16.2 per cent during the first four years of XI five year plan (2007-08 to 2010-11). Engineering products emerged as the most dynamic sector with its share in total manufacturing exports increasing from 35 per cent in 2007-08 to 39.8 per cent in 2010-11. The sector has also registered accelerated growth during the first quarter of 2011-12. The second major contributor to India's manufacturing export performance is Gems and Jewellery, with a share of 22.2 per cent. Textiles are at the 3rd place accounting for around 13.9 per cent in the total manufacturing exports, a fall from over 17.8 per cent in 2006-07(Planning Commission, 2012) (Appendix A.1) . The top four items in India's manufactured exports are engineering goods, gems and jewellery, chemicals and related products, and textiles (Appendix A.2). Since 2007-8, electronic goods have displaced leather and manufactures from fifth place with the share of the former increasing and the latter decreasing. There has been a gradual shift in India's manufacturing exports from labour-intensive sectors like textiles, leather and manufactures, handicrafts, and carpets to capital- and skill intensive sectors (Economic Survey, 2011-12).

Engineering goods exports has seen an almost steady rise in shares from 1999-2000 to the first half of 2011-12 and high growth rates of 84 per cent and 43.6 per cent in 2010-11 and the first half of 2011-12 respectively mainly due to the high growth rates of two major items machinery & instruments and transport equipments besides residual engineering items with very high growth rates. The major markets for Indian engineering exports in 2010-11 were China, the USA, the UAE, Singapore, Saudi Arabia, South Africa, Germany, Sri Lanka, and the UK. All

these markets showed tremendous export growth with China tops at 409 per cent (Economic Survey, 2011-12).

With the highest growth rate among manufactures at 58.4 per cent in the first half of 2011-12, gems and jewellery, the second major export item, has retained its share of around 16-17 per cent since 2000-1. In 2010-11, this sector accounted for 14.7 per cent of India's total merchandise exports. India is the largest cutting and polishing centre for diamonds in the world. Of the global polished diamond market, India's share is estimated to be 70 per cent in terms of value, 85 per cent in terms of volume, and 92 per cent in terms of pieces. As per the Gem and Jewellery Export Promotion Council (GJEPC), this sector as a whole supports about 34 lakh jobs. The gems and jewellery manufacturing sector consists of large number of small and medium enterprise (SME) units, employing skilled and semi-skilled labour, almost entirely in the unorganized sector(Economic Survey, 2011-12).

The share of chemicals and related products has fallen marginally over the years mainly because of the fall in shares of basic chemicals, pharmaceuticals, and cosmetics. The growth in 2010-11 and the first half of 2011-12, however, have been higher by 26.5 per cent and 34.2 per cent respectively. The steady fall in share of the textiles sector to single digits since 2000-01 is mainly due to a fall in shares of ready-made garments and cotton, yarn, fabrics, made-ups, etc. Clearly, India has not been able to utilize the opportunity provided by the phasing out of the Multi Fibre Agreement (MFA) in 2005. The rise of the electronics sector, though long overdue, is a welcome sign. This is due to the recent policies of the government to help this sector like including many electronic items in the Focus Product Scheme and customs duty exemption to many electronic components. The Tsunami in Japan which led to disruption of supply chains in Japan could also have benefitted India at a time when support measures were taken by India for this sector (Economic Survey, 2011-12).

India's Technology Intensive Manufacturing Exports

It is evident from the table 2 that the share of low-tech exports has declined from 34.19% in 1990 to 14.63% in 2011. There is a shift to medium-low and medium high tech exports.

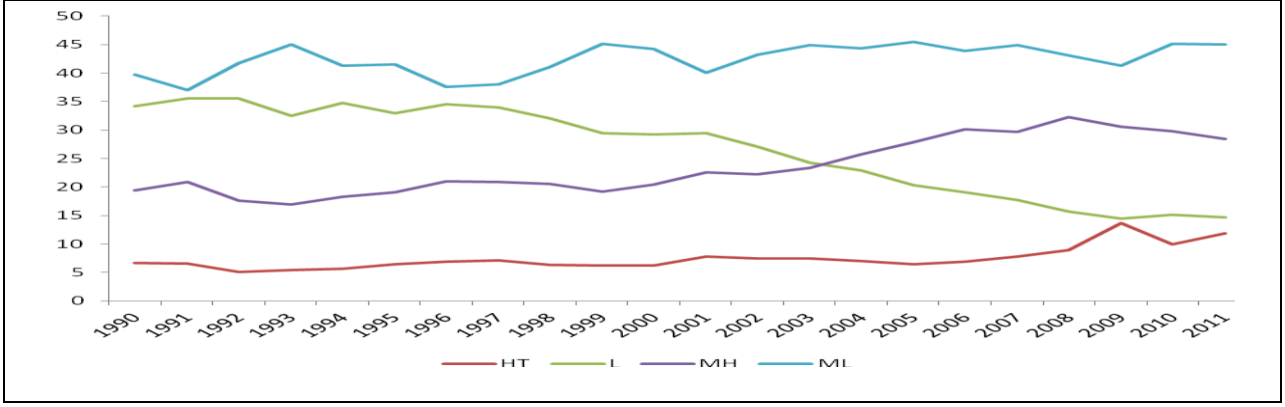
Table 2. India's Technology Intensity Exports (% share)

Year	HT	L	MH	ML
1990	6.69	34.19	19.41	39.70
1991	6.55	35.52	20.86	37.07
1992	5.12	35.54	17.62	41.72
1993	5.47	32.47	16.97	45.09
1994	5.64	34.80	18.24	41.32
1995	6.41	32.94	19.13	41.52
1996	6.94	34.49	21.01	37.56
1997	7.15	33.94	20.84	38.07
1998	6.36	32.06	20.53	41.05
1999	6.21	29.48	19.19	45.12
2000	6.24	29.19	20.39	44.19
2001	7.83	29.48	22.63	40.06
2002	7.45	27.07	22.29	43.18
2003	7.51	24.22	23.31	44.96
2004	7.03	22.89	25.78	44.31
2005	6.41	20.28	27.88	45.43
2006	6.90	19.10	30.13	43.87
2007	7.77	17.72	29.63	44.88
2008	8.94	15.73	32.25	43.08
2009	13.62	14.47	30.60	41.31
2010	9.93	15.09	29.80	45.18
2011	11.89	14.63	28.46	45.02

Source: Authors calculation from WITS UNCOMTRADE database

The major share among all technology intensive exports is in medium-low category (45.02 in 2011) and it is showing an increasing trend. The share of medium-high tech exports is increasing (19.41 in 1990 to 28.46 in2011), showing an improvement. Though the share of high tech exports is showing an increasing trend, its share is very low (only 11.89 % in 2011) compared to other tech exports (Figure 4).

Figure 4. India's Technology Intensive Manufacturing Exports

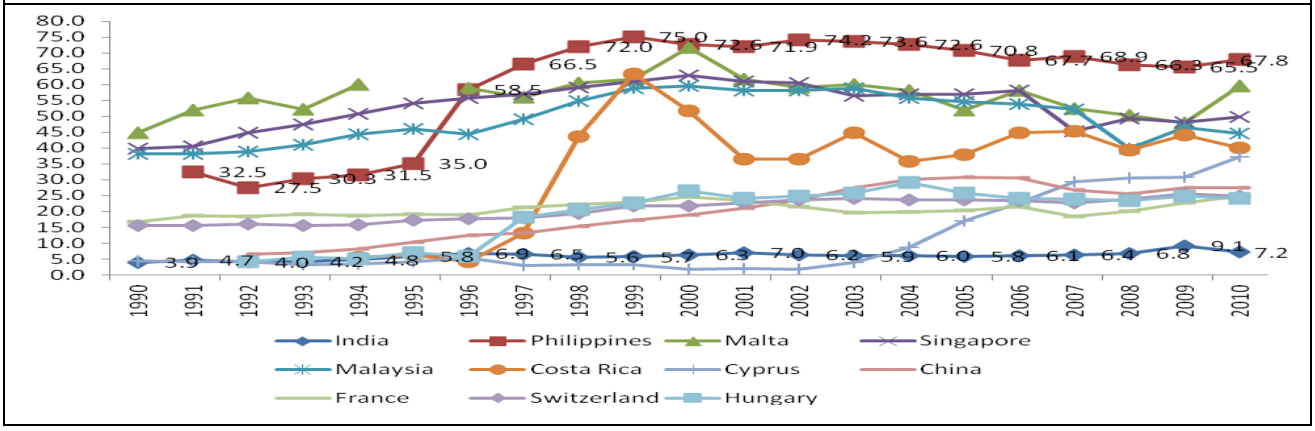


Source: Authors calculation from WITS UNCOMTRADE database

India's High-tech Exports vis-à-vis Top 10 high-tech Exporters

The World Bank data shows that the high-tech export consist a small share in India's manufacturing exports. India is yet to cross the mark of 10 percent when it comes to high technology manufacturing exports. India's weak performance in this area can be gauged from the fact that in 2010 only 7.2 percent of India's manufacturing exports were from high technology category against China's 27.5 percent. The interesting fact is that the country specializing most in high-tech exports is the Philippines, where roughly 65% of its exports fall into the high-tech category. Other outliers include Malta, Singapore, Malaysia, Taiwan and Ireland, where high-tech products account for more than a third of exports (Figure 5).

Figure 5. India's High-tech Exports(% of Manufactured Exports) vis-à-vis Top 10 High-tech Exporters



Source: WDI, World Bank, 2012

In fact a handful of typical examples of latecomer countries, such as Korea, Thailand, Costa Rica, Mexico and Hungary also perform quite well in the high-tech area. Looking at the specialization in high-tech exports, one could easily conclude that many developing countries have been extremely successful in catching up technologically and have even overtaken the United States, Japan and the EU in terms of the technological intensity of their economies (Srholec, 2005). However India seems to be seriously lagging behind in this area as share of high tech exports is only marginally increasing over the years and in fact registered a fall of around 2 percent during 2009-2010. Low levels of FDI and R&D and inadequate infrastructure could be the reasons for underperformance of India in the area of technology intensive manufacturing exports.

IV. Literature Review

The paper has reviewed some of the representative literature in the area of technological structure and performance of developing countries in manufactured exports since 1990s. In the developing countries, comparative advantage is changing from the traditional base of primary resources and cheap unskilled labour to manufactured products and services incorporating higher skill and technological inputs.[11] The export performance of developing countries are changing at different rates and in different directions; some are rapidly expanding export earnings and raising their 'quality' (shifting export structures from low-technology, low-skill, and largely labour-intensive products to high-technology and high-skill products) and others are stagnating in terms of both export earnings and quality Lall (2000)[12]. This move or progression of developing countries from traditional to non-traditional exports seems justified when one looks at the benefits conferred upon by their export diversification. As noted by Samen (2010), by providing a broader base of exports, diversification can lower instability in export earnings, expand export revenues, upgrade value–added, and enhance growth through many channels. These include:

[11] Sanjay Lall (2000), Skills, "Competitiveness and Policy in Developing Countries," *QEH Working Paper Series QEHWPS46*, http://www3.qeh.ox.ac.uk/pdf/qehwp/qehwps46.pdf;

[12] Sanjay Lall (2000), "The Technological Structure and Performance of Developing Country Manufactured Exports, 1985-1998," *QEH Working Paper Series– QEHWPS44*, http://economics.ouls.ox.ac.uk/12784/1/qehwps44.pdf;

improved technological capabilities via broad scientific and technical training as well as learning by doing, facilitation of forward and backward linkages within output of some activities which then become input of some other activities; increased sophistication of markets, scale economies and externalities, and substitution of commodities with positive price trends for those with declining price trends.

As for India's manufactured exports, Kumar and Palit (2007) point out that the latest export figures point unambiguously to a slowdown in India's merchandise exports. His analysis revealed strong deceleration in growth of manufacturing exports net of petroleum exports during the period 2004-07. In fact based on India's share in world manufacturing exports, which showed a less than 1 percent increase during 2000-2009, Mukherjee & Mukherjee (2012) noted that India's manufacturing sector's exports have had a minimal impact on global scale. Evaluating India's export performance Mukherjee & Mukherjee (2012) finds that India is still a very small player at global level especially in knowledge intensive and advanced technology products. According to him the main challenges for India for emerging as a hub for manufacturing exports are the low level of R&D and scarcity of skilled personnel. Other impediments to the realization of transition to mass manufacturing, essential for generating the required employment opportunities, are inadequate infrastructure, entry and exit barriers and low volumes of foreign direct investment.

Further, Lall (2000) said, *"Low technology products tend to grow the slowest and technology intensive products the fastest."* Lall (1999) study on India's manufactured exports concluded, "A comparative analysis of Indian manufactured exports suggests that their structure and positioning are not suited to sustained growth. The base for rapid structural change—through FDI or domestic capabilities—is weak. The current export slowdown in India reflects external conditions and may end soon; however, this does not assure rapid future growth." Lall (2000) illustrates the growing role of technologically advanced products by patterns of world trade in manufactured products. He observed the Asian share is highest in high technology products (89%) and lowest in resource based products (65%). In addition, at the country level, only thirteen – the four mature Asian Tigers, four new Tigers (Indonesia, Malaysia, Philippines and Thailand), China, India, and the three large Latin American economies – account for over 93%

of manufactured exports from developing countries. He also observed the significant differences in national patterns of specialization such as Philippines, Singapore, Malaysia, Mexico, Korea and Taiwan have very high (over 60%) shares of advanced (high plus medium technology) products in their manufactured exports, while India, China, Indonesia and Argentina are the technological laggards (with shares of below 40%).[13]

With regard to developing countries' share in manufacturing exports and high tech exports Mani (2000) showed that developing countries are increasingly becoming exporters of manufacturing products. The share of manufactured products now account for very nearly three-quarters of total exports of these countries. The share of developing countries in the total world exports has also been increasing. The analysis reveals that export structure of developing countries is increasingly moving towards technology-intensive products like capital goods. However he concluded that while share of developing countries in high tech exports is very high it is highly concentrated in five countries or so.

Desai (2011) focuses on India's changing structure of technology intensive exports which has witnessed a rapid growth an increase in their share compared to low-tech or medium tech exports in international trade since liberalization. The structural change in exports as well as technology intensive exports is quite striking suggesting the fact that technology intensive products are drivers of export dynamism. He added, "India is no exception to this and has demonstrated a sharp increase in the technology intensive products as percentage of manufactured exports in the recent period." He observed that low income countries concentrated on low-tech exports while concentration of high-tech exports occurs along high-income countries. This phenomenon has some exceptions in countries like Philippines, Singapore, Malaysia, Indonesia and China where the share of high-tech exports as percentage of manufactured exports is equivalent or much higher than many of the high-income countries. He mentioned that India largely pursued import substitution policies and hence largely biased against exports till early 1990s. He added, "In the 1950s exports were neglected and while there were conscious attempts to promote exports in the 1960s, an overwhelming portion of traditional exports were neglected and a narrow range of manufactured exports was subsidized that

[13] Lall (2000)

prevented development of any new, dynamic and technology intensive product exports." Liberalization provided opportunities for technology capacity building in high-tech sectors like automobile, pharmaceuticals, computer hardware and resource based technologies like leather (Desai 2011). During the years 2008-10, an upswing has been observed in India's exports of high-tech manufactured goods. The share of high-tech that hovered around five percent between 1990s and till recently has suddenly jumped to nine percent of the total manufactured export (World Bank, 2011).[14] Desai (2011) estimated the trend of technological intensive exports which shows that between the years 2002-03 and 2007-08, the proportion of low-tech export declined from 66 to 56 percent. As against this, the share of medium and high-tech rose to 30 from 22 and from 7 to 14 percent respectively. He concluded that "India might require greater level of coordination and policy interventions to translate the technological capabilities into higher level of high-tech exports by taking advantage of expanding markets in this sector."

Aggarwal (2001) using 'Tobit Model' analyzed that India's competitive advantages still lie in low-tech sectors. The results also suggest that in technology based sectors own technological capabilities of firms are crucial determinants of export performance of firms. It was also found that the export performance of firms was linked strongly with firm size and imports of raw materials and components in almost all technology groups.

Kumar and Pradhan (2007) observed that Indian manufacturing has not changed significantly with three-fifths of manufacturing value added still contributed by low- and medium-low technology intensive industries.

According to Meyer (2007), India's prominent position as an offshore hub for IT and IT based business services does not translate into a general specialization in sophisticated products. In fact, India's share of high-technology manufacturing exports is markedly below than that of other countries. Only 2.8 per cent of India's total exports are classified as high technology against China's over 19 per cent.

[14] Desai 2011, "Export Innovation System: Changing Structure of India's Technology Intensive Exports," http://www.ungs.edu.ar/globelics/wp-content/uploads/2011/12/ID-159-Desai-The-links-between-microeconomic-and-macroeconomic-policies.pdf;

The study very well recognizes that share of high tech products in exports is not necessarily associated with indigenous technological capabilities as pointed out by Srholec (2005). This issue was also highlighted by Lall (2000) who suggests that a significant part of the high-tech industry outbreak in developing countries might be "something of a statistical illusion", as they specialize in labour-intensive processes within high-tech-intensive industries. Similarly, Mayer et al. (2002) also noted that the rise in high-tech exports from developing countries is largely because of their increased participation in labour-intensive segments of high-tech electronics in the context of international production sharing. Despite these reservations, however, this study focuses on the structure of exports without further concerns.

V. Data and Methodology

A. The Gravity Model

In 1687, Newton discovered the law of gravitation which states that that every point mass in the universe attracts every other point mass with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.[15] On the basis of the law, Tinbergen (1962) as well as Pöyhönen (1963) and Pulliainen (1963) developed a gravity model to provide a comprehensive empirical analysis of trade flow to the world wide. The standard gravity model describes that the trade between two countries is determined positively by each country's GDP and negatively by the distance between them. The econometric representation of the gravity model can be generalized as follows:

$$X_{ij} = \beta_0 Y_i^{\beta 1} Y_j^{\beta 2} D_{ij}^{\beta 3}$$

where,

X_{ij} is the flow of exports into country j from country i;

Y_i and Y_j are country i's and country j's GDPs; and

D_{ij} is the geographical distance between the countries' capital

The linear form of the model is as follows:

[15] Wikipedia, http://en.wikipedia.org/wiki/Newton's_law_of_universal_gravitation;

$$\log(X_{ij}) = \alpha + \beta_1 \log(Y_i) + \beta_2 \log(Yj) + \beta_3 \log(D_{ij})$$

The generalized gravity model of trade states that the volume of exports between pairs of countries X_{ij} is a function of their incomes (GDPs), their populations, their distance (proxy of transportation costs) and a set of dummy variables either facilitating or restricting trade between pairs of countries. The basic model is specified as (Martinez-Zarzoso and Nowak-Lehmann, 2003: 296; Jakab, Kovács and Oszlay, 2001: 280; Hatab et al, 2010):

$$X_{ij} = \beta_0 Y_i^{\beta 1} Y_j^{\beta 2} L_i^{\beta 3} L_j^{\beta 4} D_{ij}^{\beta 5} A_{ij}^{\beta 6} eu^{ij}$$

where,

Yi and Y_j indicates the GDP of the country i and j;

L_i and L_j are populations of the country i and j;

D_{ij} measures the distance between the two countries' capitals (or economic centers);

A_{ij} represents dummy variables;

eu_{ij} is the error term and β's are parameters of the model.

B. Model Specification

The model in our study is focused on Indian manufacturing exports since liberalization. The literature on gravity model emphasized that additional variables may also be included to improve the basic gravity model based particular circumstances of the bilateral trade under study (Hatab et al., 2010; Cortes, 2007). This in turn will be the augmented gravity model for trade flow analysis. We have added some more explanatory variables to the basic gravity model, which is also an augmented gravity model for analyzing Indian technology intensive manufacturing exports. The variables included in our analysis are per capita GDP, distance, R&D expenditure, FDI and RTA.

The income is one of the most traditional variables in bilateral trade and GDP is the measure of country's market size and potential trade (Martinez-galan, 2002; Hatab et al., 2010). GDP is expected to positively related to trade.

Distance is proxy of transportation cost and the most popular absolute geographical distance variable is the distance between countries capital. An increase in distance between countries is expected to increase transportation cost and reduce trade. Hence this variable is expected to be negative (Hatab et al., 2010).

The generalized Model of our study is:

$$Ln(X_{ij}) = \beta_0 + \beta_1 \log(Y_i) + \beta_2 \log(Yj) + \beta_3 \log(D_{ij}) + \beta_4 \log(R\&D_j) + \beta_5 \log(R\&D_i) + \beta_6 FDI_i + \beta_7 RTA + eu_{ij}$$

where,

i is India and j is its partner countries.

Literature supports that the change in export shares of a country can be explained by a set of technological variables (Amable & Verspagen, 1995; Amendola et al., 1993; Dosi et al., 1990; Fagerberg, 1988; Greenhalg, 1990; Magnier & Toujas-Bernate, 1994; Montobbio, 2005; Soete, 1981). Export market shares are significantly affected by levels and changes of the skill base, R&D activities, productivity and FDIs by transnational corporations (TNCs). Baldwin and Gu (2004), Aw, Roberts, and Winston (2007), Bustos (2007), Lileeva and Tre.er (2007), Aw, Roberts, and Xu (2008) have also found evidence from micro data sets that exporting is correlated with firm investment in R&D or adaption of new technology. So R&D expenditure as percentage of GDP has been included in our model as proxy of technological innovation. Hence this variable is expected to be positively related to trade. FDI has been included in our model as source of innovation activities. Impact of FDI inflows on exports are uncertain, may be positive or negative (Arndt, 1974; Lee, 1984). According to Aizenman and Noy (2005), it is common to expect bidirectional linkages between FDI and trade in goods and they suggested that there is a strong feedback type of relationship between FDI flows and trade, especially in manufacturing goods.

The various regional trade agreements (RTA) are expected to a have significant impact on trade. According to Carrère (2006) membership of regional groupings can generate a significant increase in trade. So RTA has been included as dummy variable in our model. The dummy variable takes the value one if the importing countries have signed a free trade agreement with India. The impact of this variable is expected to be positive.

The other basic variables common language and common boarder has been omitted in the analysis for the sake of simplicity. The impact of population is indeterminate on the trade of a country. This is also supported by Oguledo and MacPhee (1994) that the effect of the population variables (for importing and exporting country) on trade is indeterminate. Population size can be trade-enhancing as well as trade-inhibiting. So it is also omitted from our analysis.

C. Data

The study considers India's top 30 major manufacturing importer countries in the period 1990-2011: United States of America (USA), United Arab Emirates (UAE), China, Singapore, Belgium, Germany, United Kingdom, Italy, Sri Lanka, Netherlands, Indonesia, Turkey, South Africa, Nigeria, Israel, Brazil, Saudi Arabia, Republic of Korea, Thailand, Malaysia, Japan, France, Bangladesh, Spain, Egypt, Australia, Russian Federation, Iran, Brunei Darussalam and Bahamas. The Tradesift analysis concluded that these countries have the largest share in total manufacturing exports of India.

Data on manufacturing exports are from the United Nations "COMTRADE" database. The nomenclature used for the manufacturing industries is SITC REV-3 at 3-digit level. The manufacturing exports are also ordered into four groups of different technological intensities, according to the OECD classification: low technological exports, medium-low, medium-high and high technology intensive exports (See Appendix A.4).

The measure for innovation is the manufacturing R&D expenditure by the manufacturing firms. Innovation is not a much crucial factor for the technological upgrading of developing countries like India. Imitation activities, adaptations to the local context of imported technologies, small incremental improvements, and learning by doing are more important (Montobbio, 2005). However, the paper considers R&D expenditure by manufacturing firms as a proxy of innovation. The R&D expenditure as % of GDP is extracted from WDI, World Bank. The lack of data availability confines the study to 16 countries out of the total 30 countries: United States of America (USA), China, Singapore, Belgium, Germany, United Kingdom, Italy, Netherlands, Turkey, South Africa, Israel, Republic of Korea, France, Spain, Australia, and Russian Federation. Data on per capita GDP (USD) and FDI inflows into India are generated from world development indicator of World Bank. The other indicator distance is used as a

proxy of transportation cost. CEPII defined distance as "it is dyadic, in the sense that it includes variables valid for pairs of countries. Distance is the most common example of such a variable, and the file includes different measures of bilateral distances (in kilometers) available for most country pairs across the world." The data on involvement in Regional Trade Agreement (RTA) has been taken from WTO.

VI. Empirical Analysis

A.Revealed Comparative Advantage (RCA)

The study applies the trade indicator RCA which reveals the comparative advantage of countries worldwide to analyze the technological intensity of manufacturing exports of India. RCA uses the trade pattern to identify the sectors in which an economy has a comparative advantage, by comparing the country of interests' trade profile with the world average.[16] Manufacturing industries listed in the Appendix A.5, classified into four categories (high technology (HT), medium-high technology (MH), medium-low technology (ML) and low technology (L)) on the basis of technology intensive exports from 1990 to 2011 (Table 3). Appendix A.3 provides further details on the definitions and on the correspondence between the different classifications involved in the study. The index of RCA is greater than one for 133 manufactured products selected from WITS UNCOMTRADE (SITC Rev-3) on the basis of OECD classification indicating that India holds comparative advantage in these products in the world market.

At the disaggregated level, average RCA is calculated for all 133 manufacturing commodities exported by India to the world during 1999-2011. The index values suggest that India's comparative advantage is focused in sectors like Pearls/precious stones, Leather manufactures, Floor coverings, made up textile articles, Cotton Fabrics/woven, organic compounds, and pig iron etc. The commodity with the maximum comparative advantage is identified as Pearls/precious stones which is medium low technology intensive manufacturing exports. High technology intensive exports have lowest average RCAs (less than 0.5) in the

[16] UNESCAP, http://www.unescap.org/tid/artnet/RCA.pdf;

selected period relative to RCAs of other classifications. Contrarily, low technology intensive exports have average RCAs ranges 1-3.5. However, the trend of RCAs in low technological intensive exports is decreasing from 3.5 in 1990 to 2 in 2011. Figure 6 clarifies the trend of average RCAs in each category during 1990-2011. Manufacturing exports of medium low and medium high technology intensive shows an increasing trend from 1900 to 2011; moving from 0.8 to 1.50 and 0.4 to 1, respectively.

Table 3. Average RCA of Manufacturing Exports of India from 1990-2011

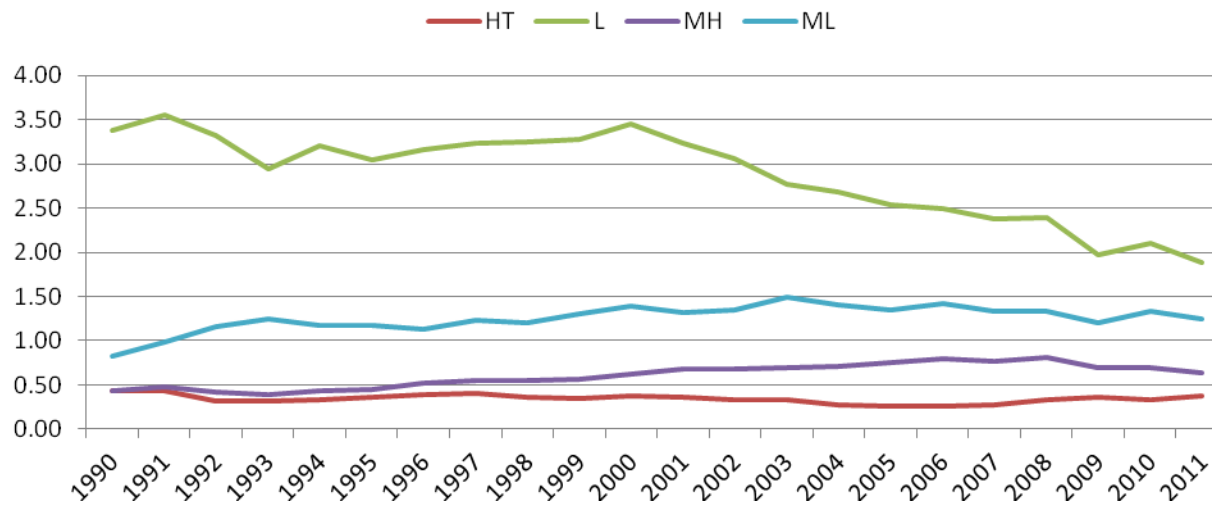
Year	Technology Intensive Manufacturing exports			
	HT	L	MH	ML
1990	0.43	3.37	0.44	0.83
1991	0.43	3.56	0.48	0.98
1992	0.32	3.32	0.41	1.16
1993	0.32	2.95	0.40	1.25
1994	0.34	3.20	0.44	1.17
1995	0.36	3.04	0.45	1.17
1996	0.39	3.16	0.52	1.12
1997	0.41	3.24	0.55	1.24
1998	0.37	3.25	0.55	1.21
1999	0.35	3.28	0.57	1.31
2000	0.38	3.45	0.62	1.39
2001	0.36	3.24	0.68	1.32
2002	0.33	3.06	0.68	1.34
2003	0.33	2.77	0.70	1.49
2004	0.28	2.68	0.71	1.41
2005	0.26	2.54	0.75	1.35
2006	0.26	2.49	0.80	1.41
2007	0.28	2.39	0.76	1.33
2008	0.33	2.39	0.81	1.34
2009	0.36	1.98	0.69	1.21
2010	0.33	2.10	0.70	1.33
2011	0.38	1.88	0.64	1.25

Source: Authors' calculation from WITS UNCOMTRADE database (SITC REV-3).

The analysis shows a steady, albeit slow shift from low technology intensive exports to medium-low technology intensive exports in India; the average RCA of low technological intensive manufacturing exports are decreasing in absolute terms and losing ground from 2001 with a peak in 2000 at 3.5, while the line graph of average RCA of medium low technological

intensive manufacturing exports hovering around 1 and heading in a positive direction. Further, the medium-high technology intensive manufacturing exports also mark improvements from 2005; increasing at a higher pace amid global worries. However, the dominance of low technology intensive exports still persists in the manufacturing exports of India (highest average RCA, 1.9 in 2011).

Figure 6. Average RCA of Manufacturing Exports (SITC REV-3) of India from 1990-2011



Source: Authors calculation from WITS UNCOMTRADE Database

B.Gravity Regression Results

The results based on fixed effect and random effect models are presented in the table 4. The result for the entire data set is presented in columns 1 and 2. For high-tech exports the result is presented in columns 4 and 5. The result of medium high-tech exports is presented in columns 6 and 7. The result of medium low-tech exports is presented in columns 8 and 9. Finally, last two columns present the Low-tech exports.

Table 4. Determinants of Technology Intensive Manufacturing Exports of India

Variable	All		HT		MHT		MLT		LT	
	FE	RE	FE	RE	FE	RE	FE	RE	FE	RE
1	2	3	4	5	6	7	8	9	10	11
Per capita GDP of importer	0.175 (0.220)	0.412[b] (1.960)	-1.145 (-0.780)	-0.039 (-0.180)	-1.163[b] (-2.800)	0.018 (0.110)	1.067 (0.800)	0.775[b] (2.080)	-0.499 (-0.650)	0.339 (1.420)
Per capita GDP of India	-1.100[a] (-3.120)	-1.222[a] (-5.540)	-0.002 (0.000)	-0.761[b] (-1.980)	-0.234 (-0.510)	-0.739[a] (-3.240)	-0.209 (-0.390)	-0.088 (-0.240)	-2.127[a] (-4.640)	-2.537[a] (-9.030)
Distance		-0.210 (-0.380)		0.405 (0.590)		0.164 (0.340)		-0.472 (-0.560)		0.643 (0.840)
R&D of Importer (% of GDP)	-0.052 (-0.130)	-0.033 (-0.180)	-1.199[c] (-1.940)	-0.749[b] (-2.290)	0.515 (1.500)	0.228 (1.390)	0.132 (0.220)	0.252 (0.780)	-0.682 (-1.430)	-0.751[a] (-2.990)
R&D of India (% of GDP)	2.421[a] (3.400)	2.348[a] (4.510)	2.787[b] (2.370)	2.482[b] (2.450)	2.603[a] (3.730)	2.457[a] (4.510)	2.187[c] (1.900)	2.172[b] (2.330)	3.010[a] (3.970)	2.869[a] (4.640)
FDI inflows in India (% of GDP)	-0.059 (-1.200)	-0.060 (-0.820)	0.025 (0.360)	0.017 (0.130)	0.046 (1.120)	0.041 (0.600)	-0.155[b] (-2.360)	-0.153 -1.430	0.021 (0.390)	0.017 (0.190)
RTA		-0.751 (-0.980)		-0.322 (-0.420)		-0.340 (-0.620)		-0.880 (-0.890)		-0.268 (-0.270)
Constant	6.347 (0.890)	6.768 (1.670)	9.559 (0.740)	0.049 (0.010)	11.508 (3.220)	2.208 (0.580)	-8.954 (-0.78)	-2.752 (-0.41)	18.413 (2.860)	7.486 (1.310)
N	180	180	180	180	180	180	180	180	180	180
R^2	0.199	0.375	0.011	0.042	0.263	0.209	0.318	0.366	0.032	0.35

Notes: [a] 1% level of significance, [b] 5% level of Significance, [c] 10% level of Significance, t-Values in parentheses**;**
HT-High-Tech, MHT- Medium High-Tech, MLT- Medium Low-Tech, LT-Low Tech;
FE-Fixed Effect Model, RE-Random Effect Model

The per capita GDP of importer countries is positively and significantly related to India's all manufacturing exports and medium low-tech exports, while it is negatively related to high tech exports. And it is significantly and negatively related to medium high-tech exports. This implies that with the increase in importers income they demand more for India's medium low-tech exports. The per capita GDP of India is negatively and significantly related to manufacturing exports except medium low-tech exports. This may be due to the fact that, a large

population in India indicates a large domestic market, high levels of self sufficiency and less need to trade. Distance is negatively related, but not significantly and it is positively related for some type of tech exports though not significantly. So inferences cannot be drawn from this result.

As expected, R&D expenditure of importer countries is negatively and significantly related to India's manufacturing exports. This implies that when importers R&D expenditure increases they go for more import substitution and import less from India. R&D expenditure of India is positively and significantly related to its manufacturing exports, implies that increase in R&D expenditure leading to increase exports of India.

FDI is negatively related to total manufacturing and significantly related to medium low-tech exports. This implies that FDI in not facilitating manufacturing exports in India. It is also positively related to high-tech, medium high-tech and low tech exports, though not significantly. As the coefficients for these (HT, MHT & LT) exports are insignificant, strong inferences on impact of FDI cannot be drawn from the result. RTA is negatively related to exports and it is insignificant. RTA with India does not seem to determine the manufacturing exports of India. This can be said that the gains from regional trade agreements are insignificant.

VII. Conclusion

The study is based on the data extracted from UNCOMTRADE-WITS database (SITC REV-3). Further, OECD classification of manufacturing industries based on technology intensity is taken into consideration. RCA trade indicator has been used to analyze the revealed comparative advantage of the technology intensive exports.

The analysis reveals a steady, albeit slow shift from low technology intensive exports to medium-low technology intensive exports in India. Though improvement was marked for the medium-high technology intensive exports, dominance of low technology intensive exports still persists. The major factors for the persistence of low technology intensive exports are low level of R&D in manufacturing sector, relatively low level of FDI and competitiveness. However, in

case of high technology intensive manufacturing exports, India still lags behind. The study highlights incentivizing high technology intensive export as a concern for the policy makers.

The major determinants of manufacturing exports of India are importer's income, R&D expenditure of India and FDI inflows. The study found that R&D expenditure is the main driver of exports and also increasing per capita income of importers is another driver of India's manufacturing exports. FDI is not significantly contributing towards export promotion of India in our study.

It is important to focus not only on so called 'high-tech' category exports, but also on medium-tech exports to promote the technology intensity of India's manufactured exports. Further, it is necessary to enable policy thrust to link up the manufacturing firms with required technology infrastructure. Government should take initiative of providing support for in-house R&D efforts that would help manufacturing industries to reach global market. In Indian manufacturing, high-tech industries are contributing less than their potential. Therefore, high technology intensive manufacturing products should get into India's export basket. Policy incentive should facilitate participation of high technology intensive manufacturing industries in global production and technology networks.

Policy efforts should be given to improve R&D expenditure, skill enhancement, more innovation activities, and more liberalize FDI inflows into India. India to derive maximum growth centric advantage through Science & Technology (S&T), its science & technology fundamentals have to be strong and excellent. Study suggests that, reforms would be required for the expansion of manufacturing sector with an aim of huge employment generation and value addition to the Indian economy.

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Appendix

A.1. Export of Manufacturing Sectors, from 2007-08 to 2010-11 *(US$ Millions)*

S1.No	Sector/ Group	2007-08	Growth in 2007-08 over previous year (%)	Share in total mfg exports (2007-08)	2010-11	Growth in 2010-11 over previous Year (%)	Share in total mfg exports (2010-11)
1	Gems & Jewellery	19807.0		20.5	33542.1		
		19807.0	**24.0**	**20.5**	**33542.1**	**15.3**	**22.2**
2	Drug, Pharmaceuticals & Fine Chemicals	7410.0	**24.7**	7.7	10324.6	15.1	6.8
3	Other Basic Chemicals	6320.5	**26.0**	6.6	8617.8	25.9	5.7
4	Plastic & Linoleum	3285.4	**1.0**	3.4	4591.9	36.4	3.0
	1+2+3	**17016.0**	**19.7**	**17.6**	**23534.3**	**22.7**	**15.6**
5	Engineering Goods	33715.5	**27.3**	35.0	60148.0	84.8	39.8
6	Electronic Goods	3355.2	**17.5**	3.5	7377.4	35.5	4.9
	5+6	**37070.6**	**26.5**	**38.6**	**67535.4**	**77.0**	**44.7**
7	Cotton Yarn/Fabs./made-ups, Handloom Products etc.	4603.5	**9.1**	4.8	5667.4	42.9	3.7
8	Man-made Yarn/Fabs./made-ups etc.	2897.0	**31.4**	3.0	4191.0	16.2	2.8
9	RMG of all Textiles	9686.5	**8.9**	10.0	11163.1	4.2	7.4
	7+8+9	**17187.0**	**12.2**	**17.8**	**21021.4**	**15.0**	**13.9**
10	Jute Mfg. including Floor Covering	329.0	**26.3**	0.3	445.6	104.7	0.3
11	Carpet	975.8	**5.2**	1.0	1130.5	53.5	0.7
12	Handicrafts excl. hand made carpet	508.2	**16.0**	0.5	220.4	-2.3	0.1
13	Leather & leather manufactures	3396.3	**15.7**	3.5	3677.0	12.0	2.4
	10+11+12+13	**5209.4**	**14.2**	**5.4**	**5473.4**	**22.6**	**3.6**
	Total Manufacturing (1-13)	***96437.2***	**21.3**	**100.0**	***151143.0***	**38.4**	**100.0**
	Total Merchandise Exports	**162904.3**	**28.9**		**245868.3**	**37.5**	
	Share of mfr sectors in total merchandise exports	**59.2**			**61.5**		

Source: Planning Commission, 2012
Note: The US$ figures are worked out using the average exchange rate for the respective period. The figures for 2010-11 are provisional and subject to change

A.2. Performance of Top Four Items in India s Manufactured Exports

Products	Shares				CAGR	Growth rate		
	1999-00	2010-11	2010-11 (Apr.-Sept.)	2011-12 (Apr.-Sept.)	1999-00 to 2008-09	2009-10	2010-11	2011-12 (Apr.-Sept.)
A. ENGINEERING GOODS	11.9	23.8	21.7	22.2	28	-18.7	84.0	43.6
1) Machinery	5.6	12.2	13.1	13.1	30.5	-13.3	55.7	40.2
a) Machine tools	0.2	0.1	0.1	0.1	20.6	-26.4	12.8	18.3
b) Machinery & instruments	3.2	4.8	4.9	4.6	28.1	-13.3	25.2	31.6
c) Transport equipments	2.2	7.3	8.1	8.4	33.9	-12.9	86.6	45.7
2)Iron & steel	2.3	2.6	2.3	2.2	24.5	-39.2	80	31.5
a) Iron & steel bar rod etc	0.3	0.4	0.4	0.5	30.4	-34.2	49.4	50.2
b) Primary & semi-finished iron & steel	2	2.2	1.9	1.7	23.5	-40.4	87.8	27.1
3)Other engineering items	4.1	9.1	6.2	7	25.9	-21.7	145.7	56.8
a) Ferro alloys	0.2	1.2	1	0.6	43.6	-43.1	234.6	-14.2
b) Aluminum other than products	0.4	0.4	0.3	0.2	14.5	11.3	79.2	0.3
c) Non-ferrous metals	0.1	3.7	1.2	1.1	60.5	5.4	323.2	29.5
d) Manufacture of metals	3.3	3.8	3.7	2.9	22.5	-27.2	70.5	10.6
e) Residual engineering items	0.1	0.1	0.1	2.1	21.3	-5.9	47.4	3512.9
B. GEMS & JEWELLERY	20.4	14.7	14.3	16.1	15.9	3.7	27	58.4
C. CHEMICALS & RELATED PRODUCTS	13.4	11.5	12.2	11.6	19.3	0.9	26.5	34.2
1)Basic chemicals, pharma & cosmetics	8.4	7.7	8.2	7.5	19.8	0.7	22	29.2
2)Plastics & linoleum	1.6	1.8	2	2.2	19.7	10.4	37.7	56.1
3)Rubber, glass & other products	2.4	2.2	2.4	2.6	18.7	-0.5	33.2	51.4
4)Residual chemicals & allied products	0.9	0.6	0.5	0.5	14.6	-5.2	43.7	29.9
D.TEXT.ILES	25	8.7	9.6	8.7	8.6	-1.2	17.1	27
1)Ready-made garments	13	4.5	4.8	4.5	9.7	-2	4.6	29.4
2)Cotton, yarn, fabrics, made-ups, etc	8.4	2.2	2.5	2.2	3.4	-11.1	48.8	22.6
3)Man made textiles & made-ups, etc	2.3	1.8	2	1.9	16.2	19.7	16.9	35
4)Natural silk textiles	0.6	0.1	0.1	0.1	4.9	-18.4	21.2	-34.4
5)Wool & woolen mfrs	0.1	0	0	0.1	8	-10.3	16.6	59.9
6)Coir & coir mfrs	0.1	0.1	0.1	0.1	13.9	7.7	-4.9	31.3
7)Jute mfrs	0.3	0.2	0.2	0.2	10.3	-28.4	110.2	-4.2
Source: Economic Survey, 2011-12								

A.3. Definitions of Technology Intensity Classification of Manufacturing Exports

1	**High Technology Industries:** High technology (HT) products have advanced and fast-changing technologies, with high R&D investments and prime emphasis on product design. The most advanced technologies require sophisticated technology infrastructures, high levels of specialised technical skills and close interactions between firms, and between firms and universities or research institutions. However, some products like electronics have labour-intensive final assembly, and their high value-to-weight ratios make it economical to place this stage in low wage areas. These products lead in new international integrated production systems where different processes are separated and located by MNCs according to fine differences in production costs.
2	**Medium-high Technology Industries:** Medium technology (MT) products, comprising the bulk of skill and scale-intensive technologies in capital goods and intermediate products, are the heartland of industrial activity in mature economies. They tend to have complex technologies, with moderately high levels of R&D, advanced skill needs and lengthy learning periods. Those in the engineering and automotive sub-groups are very linkage-intensive, and need considerable interaction between firms to reach 'best practice' technical efficiency.
4	**Low-technology Industries**: Low technology (LT) products tend to have stable, well-diffused technologies. The technologies are primarily embodied in the capital equipment; the low end of the range has relatively simple skill requirements. Many traded products are undifferentiated and compete on price: thus, labour costs tend to be a major element of cost in competitiveness. Scale economies and barriers to entry are generally low. The final market grows slowly, with income elasticities below unity. However, there are exceptions to these features. There are particular low technology products in high quality segments where brand names, skills, design and technological sophistication are very important, even if technology intensity does not reach the levels of other categories.
	Source: Lall (2000), http://economics.ouls.ox.ac.uk/12784/1/qehwps44.pdf;

A.4. OECD Classification of Manufacturing Industries based on Technology

High Technology Industries	**Medium-high Technology Industries**
Aircraft and spacecraft	Electrical machinery and apparatus, nec.
Pharmaceuticals	Motor vehicles, trailers and semitrailers
Office, accounting and computing machinery	Chemicals excluding pharmaceuticals
Radio, TV and communications equipment	Railroad equipment and transport equip, nec.
Medical, precision and optical instruments	Machinery and equipment, nec.
Medium-low Technology Industries	**Low-technology Industries**
Building and repairing of ships and boats	Manufacturing, nec., Recycling
Rubber and plastics products	Wood, pulp, paper, paper products, etc
Coke, petroleum products and nuclear fuel	Food products, beverages and tobacco
Other non-metallic mineral products	Textiles, textile products, leather and footwear
Basic metals and fabricated metal products	
Source: OECD, "ISIC REV. 3 technology intensity definition," http://www.oecd.org/sti/industryandglobalisation/48350231.pdf	

A.5. Technology Classification of Commodities at 3 Digit Level

Code	**Commodities at 3 digit level**	**Classification**	**Code**	**Commodities at 3 digit level**	**Classification**
511	Hydrocarbons/derivatives	MH	679	Iron/steel/pipe/tube/etc.	ML
512	Alcohols/phenols/derivatives	MH	682	Copper	ML
513	Carboxylic acid compound	MH	683	Nickel	ML
514	Nitrogen function compounds	MH	684	Aluminum	ML
515	Organic-inorganic compounds	MH	685	Lead	ML
516	Other organic compounds	MH	686	Zinc	ML
522	Elements/oxides/hal. salt	MH	687	Tin	ML
523	Metal salts of inorganic	MH	689	Misc. non-ferrous based metal	ML

	acids				
524	Other inorganic chemical	MH	691	Iron/steel/alum. Structures	ML
525	Radio-active etc. materials	MH	692	Metal store/transport cont.	ML
531	Synth org colour agents	L	693	Wire-production exc. Ins electro.	ML
532	Dyeing/tanning extracts	L	694	Nails/screw/nuts/bolts	ML
533	Pigments/paints/varnish	L	695	Hand/machine tools	ML
541	Pharmaceuticals excluding medicaments	HT	696	Cutlery	ML
542	Medicaments include vet	HT	697	Base metal hold equipment	ML
551	Essent.oil/perfume/flavr	MH	699	Base metal manufacture n.e.s	ML
553	Perfume/toilet/cosmetics	MH	711	Steam generating boilers	MH
554	Soaps/cleansers/polishes	MH	712	Steam/vapour turbines	MH
562	Manufactured fertilizers	MH	713	Internal combust engines	MH
571	Primary ethylene polymer	MH	714	Engines non-electric n.e.s	MH
572	Styrene primary polymers	ML	716	Rotating electro plant	MH
573	Vinyl chloride etcpolym	ML	718	Power generating equipment n.e.s	MH
574	Polyacetals/polyesters..	ML	721	Agriculture machine ex tractor	MH
575	Plastic nes-primary form	ML	722	Tractors	MH
579	Plastic waste/scrap	ML	723	Civil engineering plant	MH
581	Plastic tube/pipe/hose	ML	724	Textile/leather machinery	MH
582	Plastic sheets/film/etc	ML	725	Paper industry machine	MH
583	Monofilament rods/sticks	ML	726	Printing industry machine	MH
591	Household/garden chemical	MH	727	Food processing machines	MH
592	Starches/glues/etc.	MH	728	Special industry machines	MH
593	Explosives/pyrotechnics	MH	731	Mach-tools remove materials	MH
597	Oil etc additives/fluids	MH	733	Mtl m-tools w/o mtl-rmvl.	MH
598	Misc chemical prods n.e.s	MH	735	Metal machine tool parts	MH
611	Leather	L	737	Metalworking machine n.e.s	MH
612	Leather manufactures	L	741	Industry heat/cool equipment	MH
621	Materials of rubber	ML	742	Pumps for liquids	MH
625	Rubber tyres/treads	ML	743	Fans/filters/gas pumps	MH
629	Articles of rubber n.e.s	ML	744	Mechanical handling equipment	MH
633	Cork manufactures	L	745	Non-electrical machines n.e.s	MH

634	Veneer/plywood/etc.	L	746	Ball/roller bearings	MH
635	Wood manufactures n.e.s	L	747	Taps/cocks/valves	MH
641	Paper/paperboard	L	748	Mech. transmission equipment	MH
642	Cut paper/board/articles	L	749	Non-electro parts/accessories/machines	MH
651	Textile yarn	L	751	Office machines	HT
652	Cotton fabrics, woven	L	752	Computer equipment	HT
653	Man-made woven fabrics	L	759	Office equip. parts/accessories	HT
654	Woven textile fabric n.e.s	L	761	Television receivers	HT
655	Knit/crochet fabrics	L	762	Radio broadcast receiver	HT
656	Tulle/lace/embr./trim etc.	L	763	Sound/TV /recorders etc.	HT
657	Special yarns/fabrics	L	764	Telecomm equipment n.e.s	HT
658	Made-up textile articles	L	771	Elect power transmission equip	MH
659	Floor coverings etc.	L	772	Electric circuit equipment	MH
661	Lime/cement/construction material	ML	773	Electrical distrib. equipment	MH
662	Clay/refractory material	ML	774	Medical etc./ all diagnostic equipment	MH
663	Mineral manufactures n.e.s	ML	775	Domestic equipment	MH
664	Glass	ML	776	Valves/transistors/etc.	MH
665	Glassware	ML	778	Electrical equipment n.e.s	MH
666	Pottery	ML	781	Passenger cars etc.	MH
667	Pearls/precious stones	ML	782	Goods/service vehicles	MH
671	Pig iron etc. /ferrous alloy	ML	783	Road motor vehicles n.e.s	MH
672	Primary/prods iron/steel	ML	784	Motor vehicle parts/access	MH
673	Flat rolled iron/steel products	ML	785	Motorcycles/cycles/etc.	MH
674	Rolled plated m-steel	ML	786	Trailers/caravans/etc.	MH
675	Flat rolled alloy steel	ML	791	Railway vehicles/equipment	MH
676	Iron/steel bars/rods/etc.	ML	792	Aircraft/spacecraft/etc.	HT
677	Iron/steel railway materials	ML	793	Ships/boats/etc.	ML
678	Iron/steel wire	ML			
Source: OECD, “ISIC REV. 3 technology intensity definition,”					