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Mapping the future of high value manufacturing in India

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Working Paper 285

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Abstract

India's stagnating manufacturing sector has become a serious cause of concern for Indian policy makers. Several reasons have been identified for this slowdown, including lack of policy focus, unsupportive external environment, etc. Given the importance of the manufacturing sector and its potential to contribute to growth and employment, corrective measures must be implemented almost immediately to salvage the sector. In this context, the paper analyzes the potential for India to develop its high value manufacturing sector and provides recommendations on measures to achieve this objective. In the absence of extensive literature in this area, the paper begins by conceptualizing a definition of high value manufacturing using two different approaches. Secondary data analysis tells us that high value manufacturing in India exists only in islands. Cross country comparisons with other East Asian economies such as Korea, Japan and China reveal that India has an opportunity to develop a comparative advantage in other sectors including electronics and computer hardware. Using Hausmann's product space analysis, the opportunity set for India is identified. Consequently, using the "density" measure sectors and industries have been ranked on the basis of ease in achieving comparative advantage. The policy recommendations based on the secondary data analysis and case study interviews help us arrive at recommendations on mapping the future of high value manufacturing in India.

JEL Classification: L60, N65, O3, O14

Keywords: High Value Manufacturing; Product Space; India; East Asia; Industrial Policy; High Skill; Research and Development; Manufacturing

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Mapping the future of high value manufacturing in India

Rajat Kathuria, Mansi Kedia and Uttara Balakrishnan

1. Introduction

After independence, the overarching objective of India's economic policy was to achieve self-sufficiency with a focus on public provision of what was then characterized as the commanding heights of the economy¹. Industrialization driven by the state was seen as a necessary condition to achieve economic development and protect national sovereignty². India's *planned economy* model used industrial policy as an instrument to promote manufacturing with a view to achieve higher economic growth and equitable distribution of income, greater employment opportunities and spillover effects on other sectors of the economy³. Thus, in the first few decades after independence, India's industrial policy helped it to attain a diversified and sophisticated⁴ export basket, establishing comparative advantage in 'core'⁵ products (metals, machinery and chemicals) much more than one would expect given India's per capita income then⁶.

Beginning the 1990s, a services 'revolution' had gripped India. The empirical literature cites high income elasticity of demand, splintering of industrial activity, rising demand for services exports and the distinctive role of economic reforms in prompting services led growth in India⁷. At the same time, the share of manufacturing in GDP stagnated at around 15 percent since the 1980s and has not recovered since. *Figure 1* exhibits the sharp contrast in growth rates of agriculture, manufacturing, and services in the last five decades. According to India's recent National Manufacturing Policy (NMP 2011), the contribution of manufacturing to India's GDP is "much below potential". The target is to boost the share to 25 percent, comparable to other Asian economies where it has consistently been 25 percent or higher⁸.

India's growth stands in sharp contrast to the traditional pattern of development witnessed by developed economies in the West and that of East Asian countries including Japan, Korea and more recently China. Growth driven by manufacturing has the ability to generate spillovers, technical progress, economies of scale and induce overall productivity

¹ Daniel Yergin and Joseph Stanislaw, 1998, "The Commanding Heights: The Battle for the World Economy", Free Press

² Jadhav, 2006

³ Prior to 1991, India's industrial policies focused on *import substitution*. Panagariya (2008) provides details of the instruments of India's industrial policy since Independence.

⁴ Here the degree of diversification is defined as the number of products in which a country has acquired comparative advantage and sophistication represents the income or productivity level associated with a commodity (Abdon and Felipe, 2011).

⁵ The 'core' is a term with respect to the product space concept of Hausmann et al., 2007; which implies a network of closely connected products, mainly machinery, chemicals and capital intensive (metal) products.

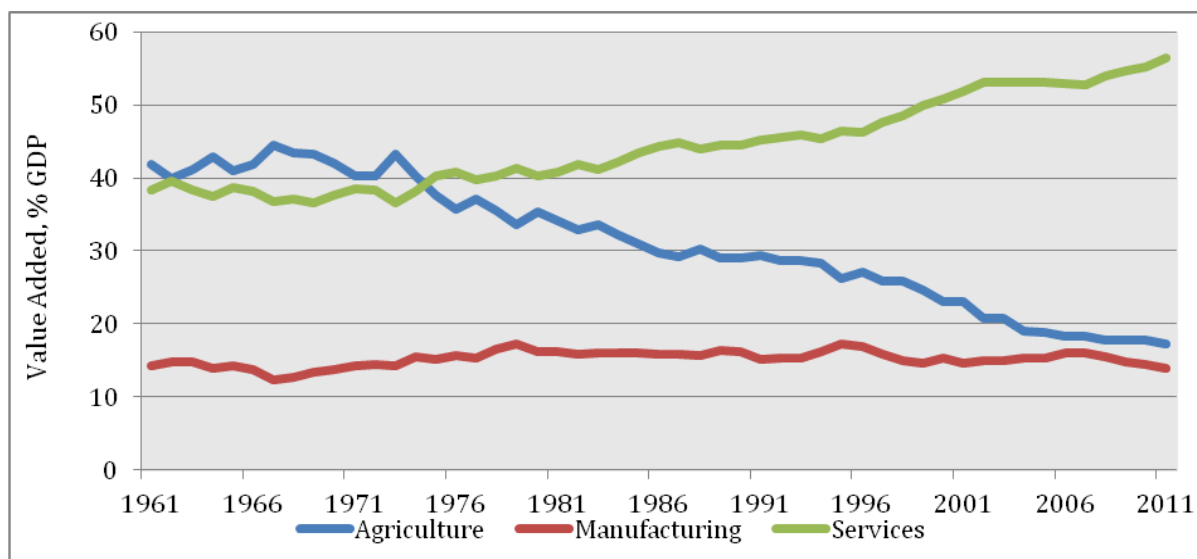
⁶ Felipe 2010

⁷ Gordon and Gupta, 2004

⁸ National Manufacturing Policy, 2011- The share of manufacturing in GDP for both China and Korea was 30 percent in 2010

improvements in the economy⁹. On the other hand, recent research hints at the possibility of services replacing manufacturing as the engine of growth, pioneering a new but robust developmental path for India¹⁰. Services can support and preserve growth by absorbing surplus labour from the agricultural sector¹¹.

Figure 1: Value Added as a % of GDP



Source: World Bank, 2013

Not everyone is as sanguine about service led growth at the expense of manufacturing, as services driven growth is considered to be temporary and unsustainable. Moreover, the enormous labour pool and unrealized potential of the manufacturing sector in India does raise the fear of ‘de-industrialization’¹². Accordingly recent policy changes recognize the need to rescue the manufacturing sector from its current state of stagnation. The National Manufacturing Policy, 2011 and the 12th Five Year Plan (2012-17) acknowledge the urgency to attain more ‘breadth’ and ‘depth’ in manufacturing, implying not only improvement in the production of similar goods but also diversifying into more complex products and moving up the manufacturing value chain¹³.

Structural transformation i.e., the reallocation of economic activity across the broad sectors, namely agriculture, manufacturing and services is a feature of modern economic growth¹⁴. Recent literature¹⁵ examines the role of structural transformation in growth diagnostics, emphasising accumulation of new complex capabilities, including high value production.

⁹ Felipe et al., 2010

¹⁰ Dasgupta and Singh, 2005

¹¹ Eichengreen and Gupta (2011)

¹² Felipe and Estrada (2008), using a logistic regression and controlling for income per capita, population and the share of trade in GDP, estimate that India’s manufacturing is about five percentage points smaller than it should be.

¹³ Lack of depth manifests in two ways in India – (i) low level of value addition in manufacturing (ii) growing imports of capital equipment which are the building blocks of manufacturing competitiveness (Planning Commission)

¹⁴ Simon Kuznets, 1971, ‘Economic Growth of Nations: Total Output and Production Structure’

¹⁵ Hausmann et al. (2007) and Hidalgo et al. (2009)

Such ‘high value’ production (and export) is facilitated by the process of structural transformation¹⁶. With companies investing in technology and process improvement, hiring in most countries (especially developed countries) has skewed towards high-skill¹⁷.

While many studies have investigated the reasons for lack of growth in manufacturing¹⁸, studying India’s absence in ‘high value manufacturing’ production is a relatively uncharted territory. One reason is the nonexistence of an internationally accepted definition of what constitutes ‘high value’. To begin with therefore, this study attempts to conceptualize a definition of ‘high value’ manufacturing based on a precise methodology. It then uses the definition to arrive at India’s current capabilities (or lack thereof) in high value manufacturing and contrasts it with our comparator countries - China, Korea and Japan. Further, the study analyzes the opportunities for structural transformation towards high value products using Hausmann’s Product Space as a tool of analysis.

The rest of the paper is organized as follows - the next section conceptualizes a definition for ‘high value manufacturing’. The methodology and results are presented here. Section three introduces the concept of product space and examines India’s exports of high value manufacturing products and the potential to develop capabilities for more¹⁹. Section four reviews the importance of industrial policy in economic development, especially with respect to high value production, and studies India’s current industrial policy for those high value industries that constitute India’s opportunity set²⁰. Section five concludes and offers policy recommendations based on an analysis of the extensive primary and secondary data. To the best of our knowledge, this paper is the first attempt to define and investigate high value manufacturing in India.

2. Conceptualizing High Value Manufacturing

2.1 Arriving at a definition of high value manufacturing

Manufacturing has seen an interesting evolution. While, in the twentieth century manufacturing essentially focused on mass assembly line production where rolling out standardized products was the norm²¹, the latter half of the twentieth century saw manufacturing characterized by flexible processes and product differentiation²². Flexible manufacturing obviated the need for ‘focused’ factories. Since new technology could assist in easily and cheaply switching from one task to another, a firm could produce a wide variety of outputs in small batches. Flexible manufacturing enabled customization and allowed firms to exploit economies of scope for the production of differentiated goods²³.

¹⁶ We define ‘high value’ in Section 2

¹⁷ McKinsey Global Institute, 2012, “Manufacturing the Future: The next era of global growth and innovation”

¹⁸ Bardhan, 2006; Mohan, 2002; Nagaraj, 2006; Panagariya, 2008

¹⁹ Product space is the theory of product relatedness first conceptualized by Hausmann et al., 2007

²⁰ Here opportunity set is defined as those products for which a country does not currently have a revealed comparative advantage >1 (Abdon and Felipe, 2011)

²¹ Milgrom and Roberts, 1991

²² Hayes and Pisano, 2000

²³ Eaton and Schmitt, 1994

In recent times, globalization has paved the way for rise in global and regional production networks, necessitating a rethink in the competitive landscape of manufacturers²⁴. India still remains a small player in world manufacturing trade, and has failed to benefit from the global value chain phenomenon despite its proximity to East Asia. Product categories such as electronics and electrical goods manufactures which are characterized by global production sharing comprise a very small share of India's network exports.²⁵

Since manufacturing has now gone beyond mere production, there is a need to develop a broader definition of manufacturing. Policy is currently designed around the existing definition of manufacturing industries which is through the use of international industry codes²⁶ that hold manufacturing and production as synonymous²⁷. Long term success requires that a firm continually seeks new ways to differentiate itself from its competition²⁸. The Institute for Manufacturing, UK equates manufacturing to the full cycle of activities from research and development, through design, production, logistics and services to end of life management. The end-to-end approach implies that manufacturing today *creates* value not just through production but through other means as well. In other words, 'high value manufacturing' *cannot* simply constitute those industries which generate high revenue through their production activities.

As stated earlier, there is no internationally accepted definition of high value manufacturing. Recently, however there have been attempts to bridge this gap. The definitions include –

- The application of leading edge technical knowledge and expertise to the creation of products, production processes and associated services which have strong potential to bring sustainable growth and major economic benefits (Technology Strategy Board UK, 2006).
- High value manufacturers can create value through unique production processes, high brand recognition, rapid delivery times or highly customized services (Livesey, 2006).
- High value manufacturers have strong financial performance, are strategically important to the regional and national economy, contribute to national R&D and have positive social impact through environment performance, sourcing policies and community involvement (Institute for Manufacturing, 2006).
- High value manufacturers are those that do not compete primarily on cost. Instead they deliver value for one or more of their *stakeholder groups* by contracting for capability,

²⁴ <http://www.globalvaluechains.org/concepts.html>

²⁵ Athukorala, 2013, "How India Fits into Global Production Sharing: Experience, Prospects, and Policy Options", Paper for the Tenth Annual India Policy Forum Workshop, India International Centre, New Delhi, 16-17 July, 2013

²⁶ International industry classifications are of broadly three types: those that classify economic activities; products and traded goods and services. The most commonly used classifications include the International Standard of Industrial Classification (ISIC); the Central Product Classification (CPC); and the Harmonized Commodity Description and Coding System (HS) and Standard International Trade Classification (SITC).

²⁷ See Appendix A for existing industry classifications and their shortfalls

²⁸ Hayes and Pisano, 2000

delivering product/service innovation, establishing process excellence, achieving high brand recognition and/or contributing to a sustainable society. There are 4 pillars that help firms achieve these ends - products, manufacturing processes, service systems and global value systems (Martinez et al., 2007).

The common characteristics in these definitions provide guidance for us to develop a functional and estimable indicator of high value manufacturing. We can divide this into two broad categories; one related to outcomes i.e. outcome related dimensions and the other to the enabling dimensions (See Table 1). Outcomes measure the ex-post impact of high value manufacturing and can be categorized into – financial, social and strategic value.²⁹ The enabling dimensions focus on inputs and processes and can be categorized into high skill; high technologically intensive; high capital intensity and high process flexibility. This is in harmony with the objectives of the National Manufacturing Policy (2011)³⁰

2.2 Approaches used to identify high value manufacturing industries

The ideal approach to estimating an indicator for high value manufacturing would be to integrate both *outcome related* and *enabling* dimensions. However paucity of data restricts such an exercise. No single data source is able to provide information for all variables across countries and over time with sufficient granularity. We therefore employ with two different approaches to develop indicators for high value manufacturing industries and products described below.

2.2.1 Approach I

This approach uses the outcome related dimensions and provides a quantitative measure of how financial, social, and strategic value – which are outcomes of the manufacturing process, are created. An index is developed using data at the 4-digit ISIC³¹ level from UNIDO's Industrial Statistics INDSTAT4 Database³².

²⁹ Using the definition of value employed by Livesey (2006)

³⁰ These include the –acquisition of technological depth in manufacturing; creation of a strong indigenous value chain addition element; and creation of appropriate skill sets

³¹ International Standard Industrial Classification

³² The database contains data at the ISIC Rev 3 level

Table 1: Outcome and Enabling Dimensions of High Value Manufacturing

Outcome related dimensions	Enabling dimensions
<p>Financial value: Financial value can be understood in terms of revenue. The most commonly used indicator in this regard is value added. Value added is generally defined as sales less the cost of bought-in materials, components, and services. It is the value generated of a product at each stage of production (Livesey, 2006). The most reliable value based measure is considered to be economic value added (EVA) which is the economic profit generated by a firm.</p> <p>Social Value: While social value for a country would be a measure of minimal environmental impact, for a firm and its employees it would be wages and salaries. According to Milberg and Winkler (2010) social upgrading is based on the concept of ‘decent work’ developed by the International Labour Organization (ILO). Decent work accounts for four aspects-employment, social protection, workers’ rights, and social dialogue. Wages and salaries is used a proxy for social value.</p> <p>Strategic Value: Strategic value measures the spill-over effects of industries on other components of the economy that are of strategic importance including sustainable employment creation.</p>	<p>Skill: According to most empirical studies in trade economics skill is measured using industry data on <i>production</i> versus <i>non-production</i> workers. However labour economists, prefer using worker’s education as a proxy for skill (Anderson et al., 2001)</p> <p>Technological Intensity: The OECD defines technologically intensive industries as those which spend a large proportion of their revenue on R&D. Moreover, products from these industries contain or embody technologies developed from R&D.</p> <p>Capital Intensity: Capital intensity in its simplest form is the relative amount of capital used in production vis-à-vis other factors of production. Capital intensity is popularly measured using capital –labour ratio in production. Other measures include return on net assets.</p> <p>Process Flexibility: Manufacturing flexibility is generally defined as the ability of a manufacturing system to respond efficiently, cost effectively and in a time bound manner to changing production needs and requirements (Kaschel and Bernal, 2006). ^[1]The variables that can be used to measure process flexibility include delivery times, service response time, sales from new products and lead time.</p>

This database provides data for India and other countries – Korea, China and Japan – making comparisons possible. Lack of disaggregate data means that we conduct the analysis at the 4 digit level. The variables used to measure the three types of value created are - financial value using value added³³; social value using wages and salaries³⁴; and strategic value using number of employees.

^[1] According to Gerwin (1993), flexibility need not always be an adaptive response to environmental uncertainty. He claims that a firm can actively encourage flexibility by making customers see the benefit of new products, shorter lead time etc.

³³ Value added was taken to be Gross/Net check. Ideally we would want to measure economic value added but given that countries do not report it means that we employ gross/net value added.

³⁴ Measured in 1000 USD across countries

The methodology³⁵ is inspired by the one used to create the Global Innovation Index (GII)³⁶. The High Value Index developed in this paper is a composite index of three separate indices – the Financial Value Index, Social Value Index, and the Strategic Value Index. Each indicator is normalized to the [0, 100] range, index is created using the min-max method with higher scores representing better outcomes³⁷. The INDSTAT4 database provides the minimum and maximum values for industries across the four countries and thus allows us to make cross-country comparisons.

Following the normalization, a combined HVM Index is constructed taking a simple average of the three separate indices. Industries exhibiting high index values are also the ones that represent high value manufacturing in each country. The advantage of the index lies in its simplicity and it is also perhaps its weakness. Since it is an index, it does not require selected variables to be independent and uncorrelated. The variables chosen to measure financial, social, and strategic value in our HVM index are potentially correlated although this does not bias the results. On the other hand, assigning equal weight to each of the three sub indices to arrive at our composite HVM index is at best a simple starting point. Neither can we justify the exact point for the switch over from low to medium and medium to high value manufacturing. Besides, missing data is a concern as country data bases do not often reflect newer industry groupings at the 4-digit level. Nevertheless the index does provide some interesting insights that are discussed below.

2.2.2 Results from Approach I³⁸

Index values computed at the 4 digit level for all four countries reveal interesting results. For India, textile fibre preparation and textile weaving has the highest value due to the labour intensive nature of production. The large numbers employed in this sector leads to a high score on strategic value. The top ten industries are dominated by labour intensive and/or resource intensive industries. India's abundance of cheap labour drives the value of the index; pharmaceuticals and automobile parts are the only two sectors not categorized as labour intensive³⁹.

³⁵ The year used for all the variables was 2007, which was the latest year for which data was available for all four countries

³⁶ The GII is a composite index of two separate indices – the Innovation Input Sub-Index; and the Innovation Output Sub-Index. The GII is the simple average of these two indices. These indices are composed of pillars which are weighted averages of individual indicators.

³⁷ $\frac{\text{Actual Value} - \text{Minimum Value}}{\text{Maximum Value} - \text{Minimum Value}} \times 100$

³⁸ Appendix B, Tables 1 - 4

³⁹ The success of the Indian pharmaceutical industry in India is a well documented story. From 1972 to 2004, India's pharmaceutical industry has grown to be the fourth largest in the world in volume terms (Haley and Haley, 2012). The size of the industry has exploded from Rs 100 million in 1947 to about Rs 500 billion in 2008. While foreign firms were the major players in the industry in 1950s and 1960s and drug prices were very high, the 1970s saw a process revolution with acquisition of technological capability helped in part by a weak patent regime. The Indian pharmaceutical industry embarked on the process of technological learning based on reverse engineering. This was facilitated by a policy environment that was very conducive and had a focused growth strategy for the industry. Section five explores the pharmaceutical industry in greater detail and provides case studies of companies and their growth stories which will provide us a perspective on the industry and its future growth prospects.

For comparator nations, China achieves the highest index value among all four countries. At 68, the index value for China is almost double that of Japan at 37, and much higher than that of Korea and India at 12 and 7 respectively. This difference is largely attributable to the strategic value index estimate for China, which is exceptionally high. In addition, since growth in China has been driven by the manufacturing sector, the financial value index is also high⁴⁰.

What is also striking in the data is the presence of similar industries among the top ten for India and China. Basic iron and steel, apparel and textile fibre preparation are common to both India and China. However in products such as electronic valves and tubes and auto components which exhibit a high index value, China's industry mix is similar to that of Korea and Japan. China has also developed a niche for itself in office and computing machinery.

The HVM index, while simplistic provides a general idea of the level of 'sophistication' in manufacturing across the four countries. It offers an insight into the country's current manufacturing capabilities, specialization and existing levels of expertise to manufacture complex, high skill, and technologically intensive goods. At the same time, the index value is driven by social and strategic values, which depend on the socio-economic and demographic features of a country. Moreover, the technical and skill related capabilities which according to most definitions are at the heart of high value manufacturing, are not accounted for in the index. We attempt to capture this aspect in Approach II below.

2.2.3 Approach II

The second approach is based on the value enabling dimensions – primarily skill and technology. Since most existing definitions for HVM emphasize the skill and technology component, this approach categorizes products with high skill and high technology as high value. We use UNCTAD's classification at the 6 digit level⁴¹ to isolate high skill and technology intensive manufactures as our HVM group⁴². This approach has been commonly adopted and allows us to identify HVM *products* as opposed to *industries* in the previous approach.

Since, technology and skill have not seen much change from the time this classification was introduced, our data set of 2011 will produce results of contemporary relevance. In this approach, products intensive in skill and technology are classified as high value manufacturing products. Of these, products that exhibit revealed comparative advantage (RCA) in the Balassa (1965)⁴³ tradition and contribute significantly to a country's exports are

⁴⁰ Manufacturing value added for China in 2010 was close to US \$ 1.1 trillion

⁴¹ The UNCTAD classification separates the products into the following categories: Non fuel primary commodities; Resource-intensive manufactures; Low skill- and technology intensive manufactures; Medium skill- and technology intensive manufactures; High skill- and technology intensive manufactures; and Mineral fuels.

⁴² <http://www.unctad.info/en/Trade-Analysis-Branch/Data-And-Statistics/Other-Databases/> (UNCTAD Basu forthcoming)

⁴³In this study we employ Balassa's (1965) measure of relative export performance by country and commodity, defined as a country's share of world exports of a commodity divided by its share of total world exports. The

analysed in greater detail to understand the underlying reasons for their competitive advantage. Data for computing revealed comparative advantage (based on the Ricardian concept of comparative advantage) and export shares have been extracted from the World Integrated Trade Solutions database (WITS).

2.2.4 Results from Approach II⁴⁴

This approach enables us to conduct a comparative factor intensity analysis of exports from India, Korea, Japan, and China. A product can be intensive in resource, skill or technology⁴⁵. Resource intensive goods which exhibit RCA form a larger share of exports from India and China compared to Japan and Korea which export a greater proportion of skill and technology intensive products. (See *Table 2*). Japan is the leader in high skill and high technology (HSHT) products that for the purpose of this study are also high value. India, China, and Korea have similar proportions of high value product exports, though we find their composition to be different (*See Appendix B Table 9-12*). Moreover, the numbers represent share in exports, the absolute values of HSHT exports from India are a fraction of that from Japan and Korea. Additionally, both India and China record a small share of medium skill and technologically intensive commodities (10 and 15 percent respectively). For Japan and Korea these numbers are higher at 31 and 22 percent respectively, reflecting the capability set developed by them to progressively move up the value chain, including necessary linkages and institutional requirements. The emergence of industrial clusters (discussed later) is a driver of HVM in these countries.

Table 2: Percentage share of exported products with comparative advantage across different skill and technology categories (HS 6 digit)

Country	High skill and technologically intensive	Low skill and technologically intensive	Medium skill and technologically intensive	Resource Intensive	Others
China	21	12	15	37	15
India	22	10	10	36	22
Japan	30	14	31	13	12
Korea	24	17	22	19	18

Source: Author's calculation from WITS (2013)

index for country i and commodity j is: $RCA_{ij} = (X_{ij}/X_{wj}) / (X_i/X_w)$. The RCA can take a value between 0 and $+\infty$. If the $RCA > 1$, then the country has a revealed comparative advantage in the particular product.

⁴⁴ The analysis in this section uses data from 2011 which is the latest year for which data for all four countries is available.

⁴⁵ Factor intensity provides the relative proportion of the various factors of production used to make a given a product.

Focusing only on high skill and technology intensive goods we find that India has a comparative advantage in 270 of the total 1024 such products at the HS 6 digit level. The top 10 list of HS 6-digit high skill and technology intensive products in descending order of their RCAs is provided in *Appendix B Table 5*. It is interesting to note that for India, products with high RCAs are not necessarily those with high export shares (*Appendix B Table 9*), *other organic compounds* being an exception among product categories. -. This can be explained by the low share in world exports of commodities such as benzene, insecticides, polypropylene, etc. Very few countries engage in the export of these products. This phenomenon is also true for a few commodities in other countries. (*Appendix B Table 10-12*)

Pharmaceuticals, basic chemicals, and plastics are HSHT products exported from India with revealed comparative advantage. These products also have the highest share in total exports from India. Mapping these products to the ISIC code shows the industries they represent. Table 3 below provides a summary of the top five industries (using ISIC codes).

Table 3: Top five ISIC industry categories based on the number of high skill and technology intensive commodities with RCA>1, India (2011)

Rank	ISIC Code	ISIC industry description
1	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
2	2423	Manufacture of pharmaceuticals, medicinal chemicals and botanical products
3	2429	Manufacture of other chemical products n. e. c.
4	2413	Manufacture of plastic in primary forms and synthetic rubber
5	3330	Manufacture of watches and clocks

China's high value products comprise of office, accounting and computing machinery, television and radio transmitters, apparatus for line telephony and line telegraph, electronic valves and tubes, and other electronic components which represent the top HVM industries in both Korea and Japan⁴⁶.

In addition to the products mentioned above, Japan and Korea enjoy a competitive advantage in the manufacture of television and radio receivers, sound / video recording and reproducing apparatus as well. These are products for which East Asian countries have a demonstrated advantage. Arguably, industrial policy in Korea and Japan has been a causal factor in the transition from low skill-low technology to high skill- high technology manufacturing. Our data shows that, Japan and Korea are ahead of China and India, much more so than India, in terms of export values for HSHT products. India thus is a laggard in HSHT products in the comparator group. This result sets the background for the analysis in the next section on product space analysis, which attempts to map India's opportunities in HVM, given the current capability set.

⁴⁶ Section four talks about the policies that have facilitated this transition

3. Product Space Analysis of India's Export Basket

3.1 Introduction

According to Heckscher-Ohlin, a country's exports are driven by its relative endowments of land, labour and capital. A country exports products that use the abundant factor intensively. This fundamental insight is corroborated and extended by Hausmann, Hwang, and Rodrik in their work on production structures. They argue that specialization patterns are also, in part, shaped by idiosyncratic elements and path dependencies. Economic growth in turn is influenced by levels of "sophistication" in a country's production. The nature of production matters for economic growth. Countries that specialize in the production of goods with higher productivity are better placed to achieve higher growth. Hausmann et al. (2005) calculate the incomes/productivities associated with each product (they call it *PRODY*⁴⁷) and the incomes/productivities associated with a country's export basket (they call this *EXPY*⁴⁸). *PRODY* is effectively the 'sophistication' level of a product. Products with high values of *PRODY* are complex and ahead in the manufacturing value chain. Estimated values for *EXPY* are highest for East Asian countries such as South Korea and China given their dependence on exports and on goods with high productivity (Hausman et al. 2005).

The 'Product space' analysis-a theory of product relatedness- is an extension of the above approach. Developed by Hausmann and Klinger in 2007, the theory emphasises the *initial* pattern of specialization. The location in the product space is a crucial determinant of a country's potential to develop comparative advantage in certain products. Countries progress by exploiting the relatedness of products requiring similar inputs including skills and technology, besides institutional and infrastructural needs. Thus, development is not merely advancement in general attributes such as education, health, rule of law and infrastructure but also the development of ancillary support systems and activities that are specific to an industry⁴⁹.

A country's product space maps its export status at a given point in time. It consists of a central dense core made up of machinery, metal products, chemicals and capital intensive goods. At the periphery are products such as petroleum, seafood, garments and raw materials-products that are weakly related to other products. In general, products along the periphery are less sophisticated with lower income elasticity than those at the core⁵⁰. The size of the product node represents the proportion of a good in the country's total exports and those with RCA are highlighted. Industries are differentiated by colours. The industry clusters are striking similar to the classifications introduced by Leamer⁵¹. While all industry clusters are

⁴⁷ *PRODY* provides a measure of the income content of a product. Let the per capita GDP of a country j be Y_j . Then the productivity level associated with product k is:

$$PRODY_k = \sum_j [(x_{jk}/X_j)/(\sum_j (x_{jk}/X_j))] * Y_j$$

⁴⁸ *EXPY* is the productivity level of a country i 's export basket. *EXPY* is the weighted average of the *PRODY* for a country where the weights are the value shares of the products in the country's total exports.

$$EXPY_i = \sum_l (x_{il}/X_i) * PRODY_l$$

⁴⁹ <http://www.hks.harvard.edu/news-events/publications/insight/markets/ricardo-hausmann>

⁵⁰ Abdon and Felipe, 2011

⁵¹ E. Leamer, *Sources of Comparative Advantage: Theory and Evidence* (MIT Press, Cambridge, MA, 1984).

not of the same size, products belonging to the same industry have stronger links, i.e. higher proximity.

The product space map is a very useful tool to study a country's exports and the potential for increasing the level of sophistication of its exports. Some contemporary research includes Cruz and Riker's analysis of Brazil's exports using the Product Space Map (2012)⁵², Abdon and Felipe's paper on opportunities for growth and structural transformation of Sub-Saharan Africa (2011)⁵³, Hamwey *et al.*⁵⁴ on mapping green product spaces of nations (2012), Bogetic *et al.* on expanding and diversifying Montenegro's Exports (2013), Caglar on export promotion strategies in Turkey (2011), African Development Bank study on comparative export policies in Egypt, Morocco, Tunisia, and South Korea. In 2011, a World Bank study by Mishra, Susanna Lundstrom, and Anand used the product space concept to study services export sophistication and economic growth.

India's current product space map represents a less dense core with chemicals and metal products industries exhibiting RCA.⁵⁵ The previous section identified a number of HVM products that represent India's opportunity set. In the following section we use the product space map to identify India's potential to develop HVM products.

3.2 Analyzing India's product space relative to China, Japan and Korea

Comparison of the product space map across four countries reinforces some of our earlier findings of the index approach. The product space maps of both India and China below show RCA for peripheral low productivity labour intensive sectors such as textiles (dark green cluster). China's RCA in electronics (blue cluster) demonstrates a greater ability to export complex products compared to India. While India shows competitiveness in chemical products (dark pink cluster), China has moved beyond to create a niche in the core as shown in *Table 4 below*. China's ability to accumulate more complex capabilities has been policy induced and not entirely market driven⁵⁶. Although India does manufacture some of these high value products, they are not internationally competitive. A more detailed policy analysis is provided in Section 4.

Japan and Korea have evolved product spaces quite different from that of India. A significant portion of their exports originate from the core, namely electronics, machinery and chemical products with large associated spillover benefits. The composition of the HVM products exported by both countries is similar (*details in table 4*), with Japan dominating in terms of the magnitudes of RCA.

⁵² Cruz and Riker, 2012, "Product Space Analysis of the Exports of Brazil", Office of Economics Working Paper, US International Trade Commission

⁵³ Abdon and Felipe, 2011, "The Product Space: What does it say about the opportunities for growth and structural transformation of Sub-Saharan Africa?", Levy Economics Institute, Working Paper No. 670

⁵⁴ Hamwey, Pacini, Assuncao, 2012, "Mapping Green Product Spaces of Nations", Journal of Environment and Development

⁵⁵ Felipe *et al.*, 2010

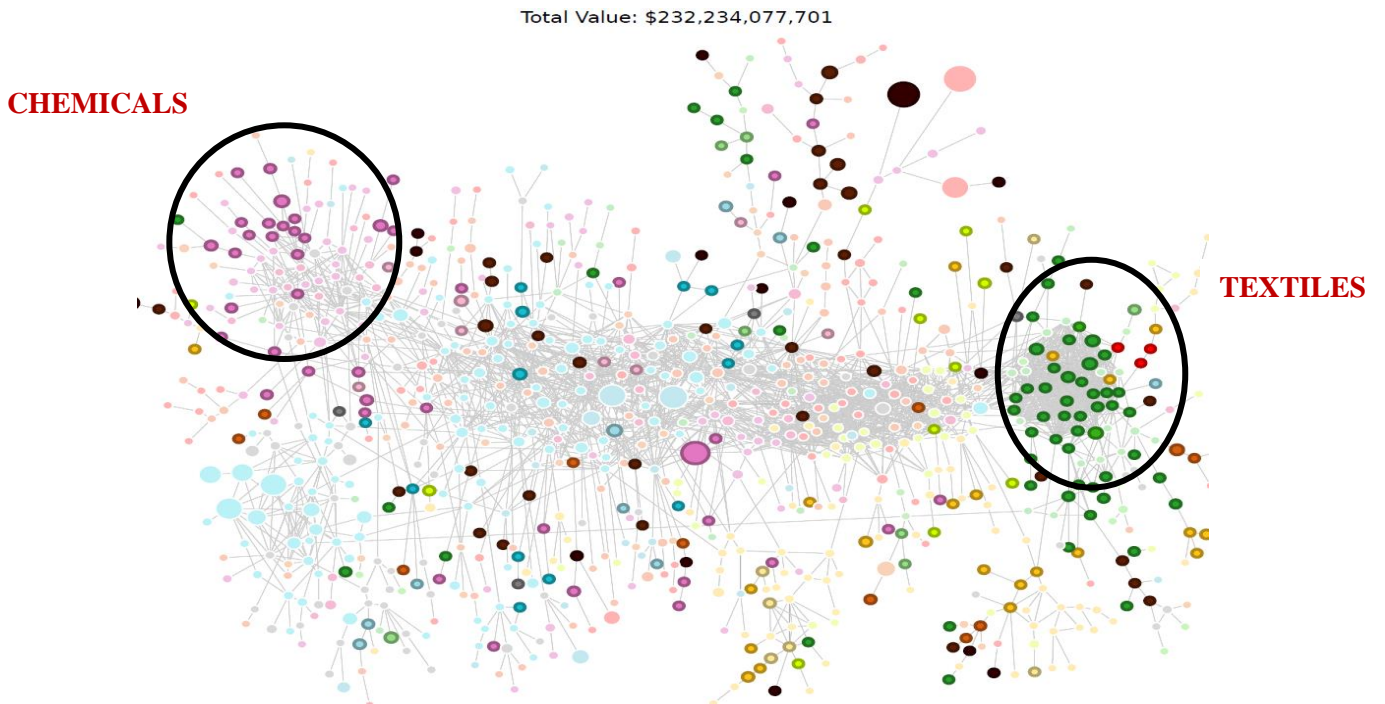
⁵⁶ Abdon and Felipe, 2011

Table 4: Cross-country analysis of HVM exports at HS 4 digit level

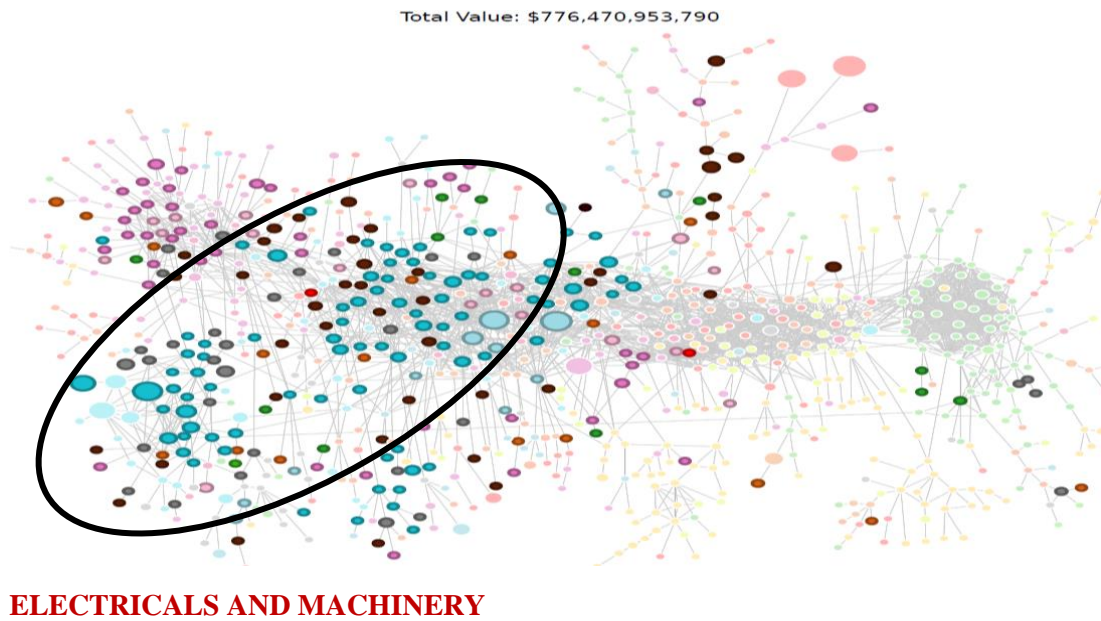
Country	Export of HVM Products (RCA >1)	Export of HVM Products (RCA <1)	Description of Products with RCA >1
India	60	191	<ul style="list-style-type: none"> a) Products from chemical and allied industries b) Plastics and thereof c) Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus, parts and accessories thereof
China	104	148	<ul style="list-style-type: none"> a) Products from chemical and allied industries b) Plastics and thereof c) Machinery and mechanical appliances, electrical equipment, parts thereof, sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles d) Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus, parts and accessories thereof
Japan	103	148	<ul style="list-style-type: none"> a) Products from chemical and allied industries b) Plastics and thereof c) Machinery and mechanical appliances, electrical equipment, parts thereof, sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles d) Aircraft, spacecraft, and parts thereof e) Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus, parts and accessories thereof f) Clocks and watches and parts thereof
Korea	60	189	<ul style="list-style-type: none"> a) Products from chemical and allied industries b) Plastics and thereof c) Machinery and mechanical appliances, electrical equipment, parts thereof, sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles d) Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus, parts and accessories thereof e) Clocks and watches and parts thereof

Source: Author's calculations

Product space map of India (2010)

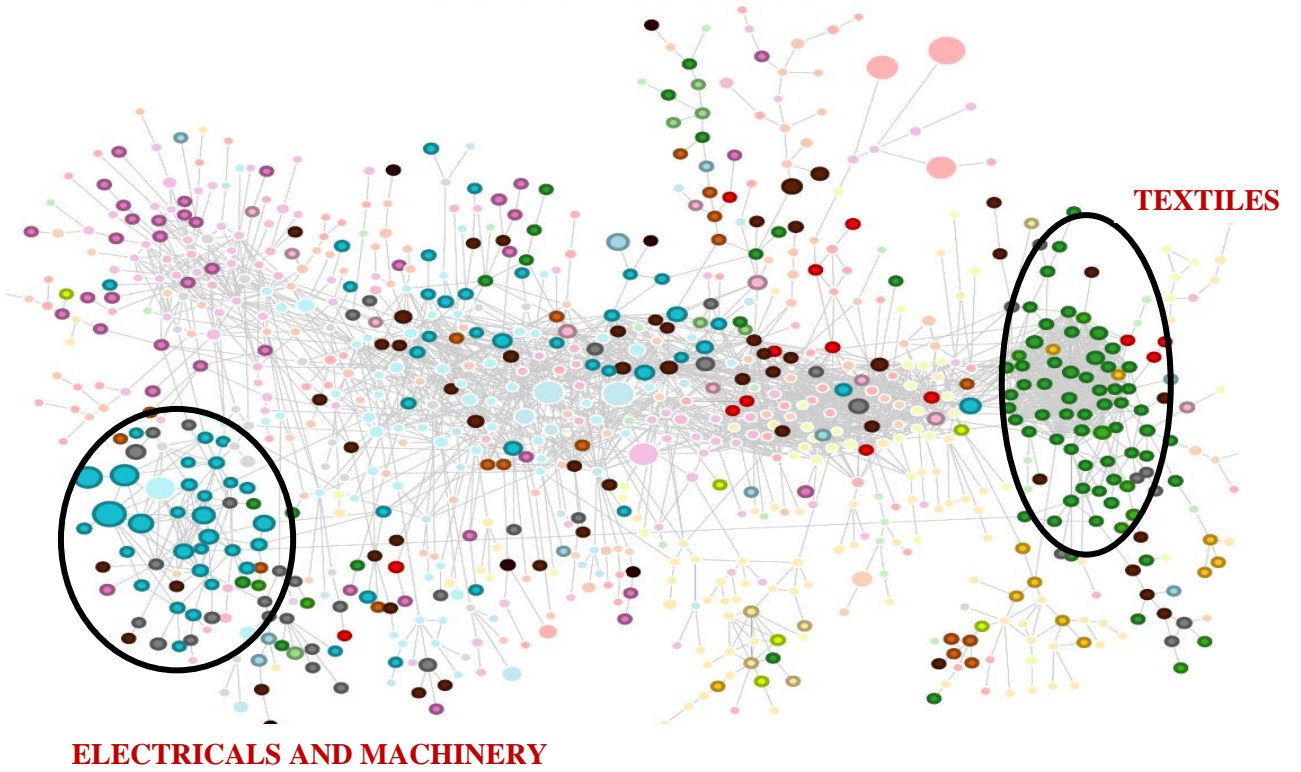


Product space map of Japan (2010)



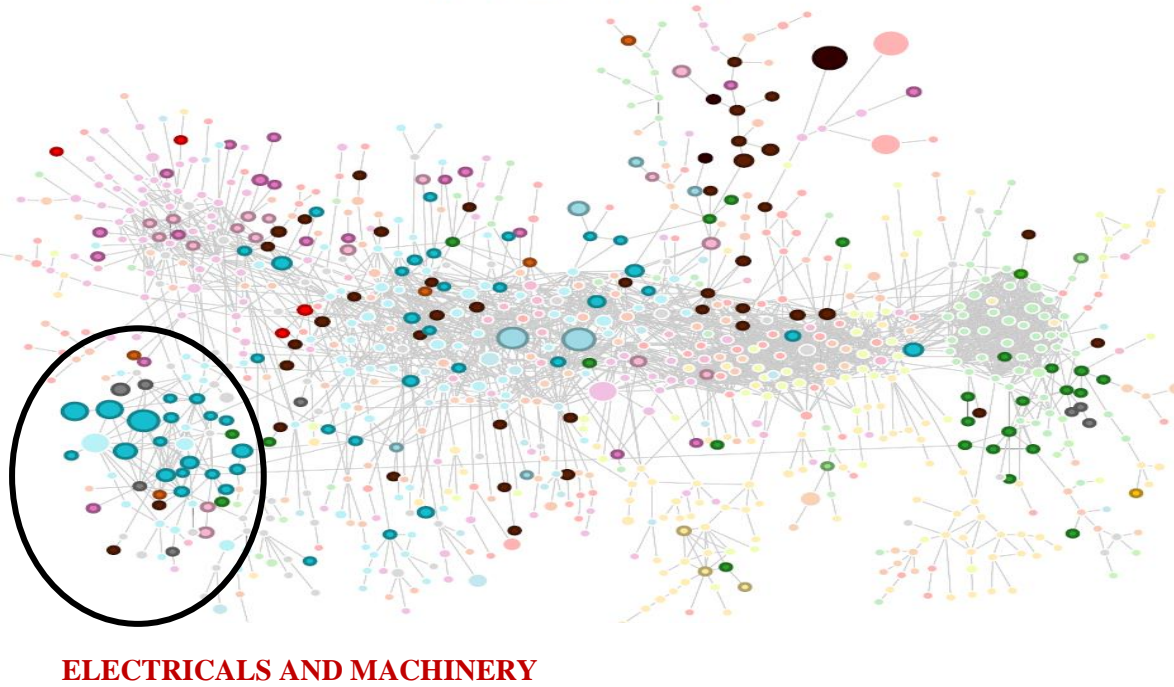
Product space map of China (2010)

Total Value: \$1,745,120,532,941



Product space map of Korea (2010)

Total Value: \$472,830,180,847



3.3 Opportunities for Structural Transformation

As stated above, the network representation of the product space is a powerful tool to assess the potential for developing comparative advantage in exportables. The proximity matrix helps measure the probability that a country can develop capabilities for a new product given that it enjoys comparative advantage in a related product. Following Felipe and Abdon (2011), this depends on the existing *level of diversification*⁵⁷ of exports and the *distance* of the country's opportunity set to its current export basket. The 'distance' is defined in Hausmann and Klinger (2006) as the *density*, which is a country-product level measure. The density of a product j not exported with a comparative advantage is calculated as the sum of proximities between j and all those products the country exports with a comparative advantage scaled by the sum of all proximities leading to j :

$$density_{cj} = \frac{\sum_i \Phi_{ij} x_{ci}}{\sum_i \Phi_{ij}}$$

where, $x_{ci} = 1$ if $RCA \geq 1$ and is 0 otherwise and Φ_{ij} denotes the proximity⁵⁸ between goods i and j .

The density of a product always lies between 0 and 1. The higher the estimated density, the easier it is for the country to develop export capabilities. The density is a proxy for the probability that a country successfully develops the capability to export a product with comparative advantage, given its current exports. For the purpose of this part, HVM products identified on the basis of *approach II* above are separated into those exported with $RCA > 1$, and those which are not (*Please see Table 4 above*). Densities have been calculated for all HVM products (at HS four digit level) that do not currently enjoy a comparative advantage⁵⁹. The products are then classified into three quartiles according to their densities. According to results in *Table 5*, about three quarters of HVM products in India have an average density of about 0.25. Moreover, the maximum density is 0.30 and the range of the density values is also low. This means that within India's opportunity set most HVM products are at a considerable 'distance' from products that are currently exported with a comparative advantage. One implication of this result is that relative to East Asian countries, India might need a bigger policy push to move towards the core of the product space. Significantly, India has the highest number of products in its opportunity set of HVM products, closely followed

⁵⁷ Export diversification can be horizontal, vertical, and even diagonal. Horizontal diversification is adding new products to existing ones, vertical diversification is moving from commodity to higher value added manufactures, and diagonal entails a shift from imported input into secondary and tertiary sectors

⁵⁸ Proximity is calculated as the probability of exporting product A given that the country exports product B. The idea behind this conditional probability is that products use knowledge (capabilities) as input. The similarity between the capabilities required to produce two products is inferred by the probability of co-exporting them, that is, it is assumed that if two goods share a high number of common inputs (capabilities), the country that exports one of them will also export the other one; and vice versa, that is, products that share a few capabilities are less likely to be co-exported. For example if 20 countries export computers (product A), 24 countries export wine (product B) and 8 export both, the *proximity* between computers and wine is $8/24=0.3$ (we divide by 24 instead of 20 to minimize the number of false positives).

⁵⁹ Products with a revealed comparative advantage less than 1

Korea, and then Japan and China. China has the highest density of 0.547 along with the highest range of 0.236 amongst the four countries. This implies that China has the most diversified product space among the four countries and the highest potential for developing capabilities among the comparator countries. This analysis does not include products that are completely absent from the country's export basket.

Table 5: Descriptive Statistics for Density Estimates for HVM Products with RCA<1 at HS 4 digit

	India	Korea	China	Japan
Lower Quartile	0.219	0.181	0.371	0.260
Median	0.232	0.194	0.395	0.283
Upper Quartile	0.248	0.204	0.411	0.313
Minimum	0.189	0.160	0.311	0.175
Maximum	0.303	0.294	0.547	0.355
Range	0.113	0.134	0.236	0.179
No. of observations	191	189	148	148

Products exhibiting high densities for India have been ranked in *Table 6* (Top 10). While products with potential to develop a comparative advantage all lie within a narrow range of densities, the corresponding level of sophistication as measured by PRODY (see section 3.1 above) shows more variability. *Table 7* lists the top ten products (at the four digit level) with the highest levels of sophistication of India's potential HVM exportables and traces these back to their 4 digit product code. The two common product categories among the top 10 products exhibiting both high levels of sophistication and high densities are 3103 and 2814. These belong to the chemical cluster in India's product space map. While one could identify policy impediments that prevent India moving up the value chain in the chemicals cluster, all products estimated to have high PRODY (levels of sophistication) deserve attention because of their potential to create positive externalities. Additionally, there are several product categories, especially those at the core of the product space which are not exported from India, and therefore do not feature in this analysis, which require serious policy intervention.

High value products that are currently exported from India, and have the ability to gain comparative advantage are represented in the scatter plot below (*Figure 2*) along the density and sophistication axes. Most products are bunched in terms of density and levels of sophistication, except for a few outliers such as paints and varnishes (3210) and Cinematographic Cameras and Projectors (9107) and products for soap preparation (3105) that have either high levels of sophistication or high densities. While the new thinking on industrial policy is sympathetic to picking sectors/ products that have strong externalities, it is

also fraught with risk especially because of political economy considerations in India. In the next section we discuss enabling policies for manufacturing at the macro-level based on successful strategies adopted by comparator countries. Policies for specific industries or industry clusters need much more caution, but ultimately these might be necessary to pull India out of its current state of stagnation in manufacturing.

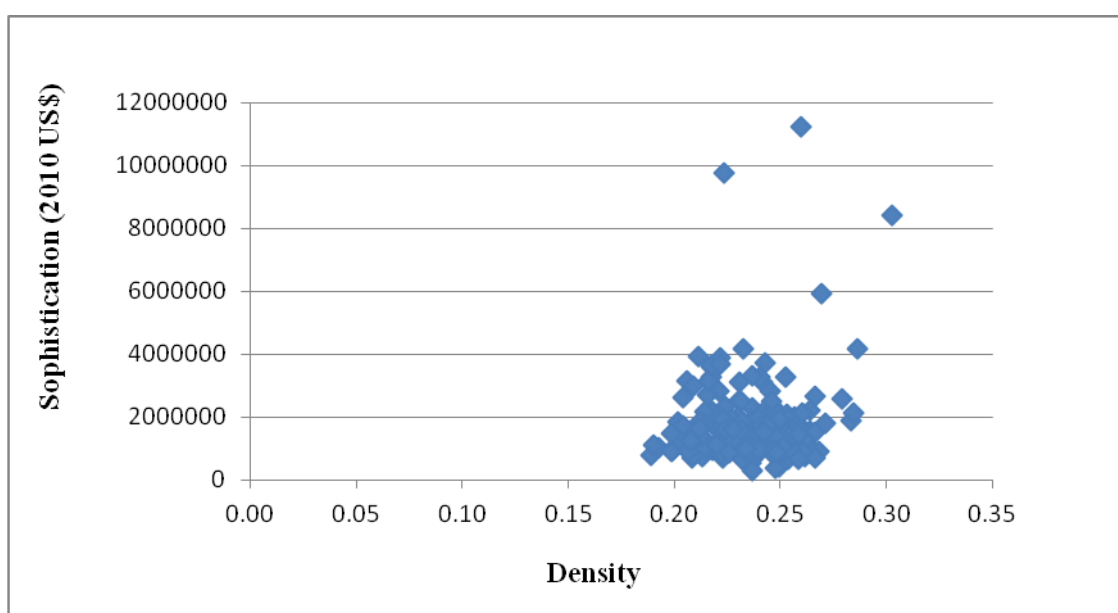
Table 6: Top 10 densities, India

Product Code (HS 4 digit)	Density	Product Description
3401	0.303	Soap; organic surface-active products in bars,
3103	0.287	Mineral or chemical fertilizers, phosphatic
3105	0.285	Mineral or chemical fertilizers, nes; other fertilisers
2207	0.283	Ethyl alcohol, under-natured of $\geq 80\%$ alcohol, de
2834	0.279	Nitrites; nitrates
3201	0.271	Tanning extracts of vegetable origin; tannins a
2814	0.269	Ammonia, anhydrous or in aqueous solution
2841	0.268	Salts of oxometallic or peroxometallic acids
3805	0.267	Gum, wood or sulphate turpentine... oils; crude
8469	0.266	Typewriters and word-processing machines

Table 7: Top 10 products by PRODY (India)

HS 4 digit Product Code	Product Description
3210	Other paints and varnishes
9007	Cinematographic Cameras and Projectors
3401	Organic Surface- active products and preparations for use as soap
3501	Casein, Caseinates and other derivatives
2814	Ammonia, Anhydrous or in aqueous solution
9101	Wrist Watches, Pocket Watches, and Other watches
3103	Mineral or chemical fertilisers, phosphatic
3807	Wood tar, wood tar oil, etc.
2818	Artificial Corundum, whether or not chemically defined
2851	Other inorganic compounds

Figure 2: Scatter Plot for sophistication and density of HVM products, India



4. Policy Analysis

4.1 Lessons from East Asia

The role of government in inducing structural transformation, industrial upgradation and economic growth cannot be overemphasized. This is especially relevant in the context of East Asian countries. Twenty three economies in the region have grown faster than any other region from 1965-90⁶⁰. East Asian economies surpassed African nations and most Latin American countries that were richer in the 1960s (Table 8). The growth in East Asia occurred due to appropriate integration of economic, political and institutional policies⁶¹. India can draw lessons from specific policies of East Asian countries that placed manufacturing at the core.

Table 8: Comparative growth experience, Per-capita GDP (2005 dollars)

Country	1960	1985	1995	2011
South Korea	155.21	2367.78	11467.81	22424.06
Japan	478.99	11465.73	42522.07	45902.67
China	92.01	291.77	604.22	5444.78
India	84.13	301.58	380.09	1488.51
Brazil	208.43	1636.31	4751.06	12593.89
Mexico	339.83	2421.69	3107.07	10047.13
Ghana	180.62	349.93	380.32	1570.13
Senegal	260.12	475.29	582.94	1119.35

Source: World Bank (2013)

⁶⁰ Page, 1994

⁶¹ Stiglitz, 2007

Industrial policy in East Asia, beginning with Japan, was based on two broad objectives – to promote infant industries and to encourage exports. In the initial stages of development, Japan leveraged its comparative advantage in labour intensive exports with simultaneous focus on production of complex products. The structural transformation in Japan was driven by technical progress and knowledge accumulation. As Japan gradually moved into more capital intensive and technologically sophisticated activities, low end production shifted to other East Asian countries where the cycle was repeated⁶². Akamatsu's (1961,1962) third flying geese paradigm explains this phenomenon, as commoditized goods move from advanced countries to less advanced ones. Hong Kong, Singapore, Taiwan and South Korea (Ozawa, 2006), the new industrialized economies (NIEs) became the second tier of nations to develop capabilities in advanced technologies and complex manufacturing.

Industrial policy facilitated this paradigmatic shift in East Asia. These policies were outward-oriented, though globalization was 'measured' and 'paced'⁶³. Focus on export-led growth did not imply a *laissez faire* economy. The governments carefully crafted an industrial policy of 'picking winners', identifying sectors with potential for high productivity, demand elasticity, and employment generation. Accordingly, investments were made in sectors such as electronics, computers and computer chips. In Japan this policy was facilitated by the Ministry of International Trade and Industry (MITI) using instruments of trade protection, tax advantages, subsidies and cheap credit. Private sector R&D was also actively promoted through subsidy that was one of the largest components of fiscal expenditure by the Japanese government⁶⁴.

In Korea, the 'picking winners' strategy saw deliberate creation of large conglomerate groups called *chaebols*⁶⁵. Some examples include Daewoo, Samsung and Hyundai. Operations of conglomerate groups were facilitated by controls on foreign investment inflows and proprietary technology. Unlike most developing countries, which relied on private agents to promote industry in the post liberalization era, Korea created public enterprises which became the launching pad for new industries.

More recently, China's growth resembles this pattern. Industrial policy in China was a combination of an 'open door' policy to attract foreign direct investment, creation of Special Economic Zones (SEZs) to invite investments in low technology and light industry sectors, Open Port Cities (OPCs) to attract advanced technologies and promote industrial upgradation, Free Trade Zones (FTZs) and High Technology Development Zones (HTDZs) for export promotion. These policies had knock on effects on domestic research and development.

⁶² Briefly, Akamatsu's (1961) flying geese theory is a development paradigm where Japan first pioneered the economic growth model of moving up the manufacturing value chain through a combination of export led growth and public policy initiatives and the other East Asian countries, including Korea, followed suit. According to the theory, Japan first moved up the development ladder and exported low end manufacturing to Korea and the other East Asian countries that then did the same as they progressed towards high value manufacturing.

⁶³ Stiglitz, J. 2007. 'Making Globalization Work'. W. W. Norton & Company.

⁶⁴ Noland, 2007

⁶⁵ The *chaebols* are large, conglomerate family-controlled firms of South Korea characterized by strong ties with government agencies. For more on Chaebols refer <http://www.sjsu.edu/faculty/watkins/chaebol.htm>

Industrial upgrading within the Chinese economy is apparent in its rapidly declining exports of labour intensive products such as clothing, apparel, textiles and footwear (from about 40% in the early 1990s to less than 20% in 2006). In contrast, exports of advanced manufactured products such as electronic equipment have grown⁶⁶.

4.2 History of Industrial Policy in India

Industrial policy (or the lack thereof) has played a key role in the fate of manufacturing in India. According to Bardhan (2006) industrial policy and poor infrastructure (social and physical) were together responsible for constraining manufacturing prior to the 1991 reforms. Among developing countries, India's growth experience during the past six decades has been unusual. Unlike many of its East and Southeast Asian neighbours, India did not grow at "miracle" rates that reached as high as 10 percent. For three of the six decades (1950–80), India's economy grew steadily at the so-called 'Hindu rate of growth of 3.5 percent a year in real terms, and during the next two decades it grew at annual rates between 5 and 6 percent.⁶⁷ In the Golden Period from 2003-04 to 2007-08, India saw an average growth rate of 9 percent. The high growth rate has been attributed to high investment, open trade policies and market financial reforms that have been periodically introduced. At the heart of the reform measures were the successful completion of several privatization initiatives (as distinct from disinvestment of minority stakes) and the further relaxation of the FDI regime.⁶⁸ The Economic Survey (2012-13) underscores the strong correlation of growth with investment rate.

Industrialization and economic growth are important national goals among others such as redistribution, welfare and maintaining sovereignty. India's Federal structure however makes policy formulation and implementation complex and moreover, it is often politicized, either because of Centre-State conflicts or because the State is too weak to implement its own policies. Certain states have been relatively more successful in attracting investment but are not immune to the criticism that weaknesses in institutions and inability to pursue a cohesive development agenda, in general, detract from economic growth. For example, in West Bengal, failure of the Tata Motors to acquire land due to the political conflict has discouraged investors.⁶⁹ By contrast, Gujarat where Tata Motors eventually invested has pursued a pro growth strategy with salutary results on investment, although social indicators have lagged behind.⁷⁰ At the Centre, after many years, India has shifted from a reluctant pro-capitalist state with a socialist ideology to an enthusiastic pro-capitalist state with a neo-liberal ideology.⁷¹ This shift has significant implications for the future of economic growth in India, including the possibility of developing and consolidating HVM in India. Box 1 highlights the success story of India's automobile industry in this regard.

⁶⁶ Yueh, 2012

⁶⁷ Arvind Panagariya, "India's Trade Reform"

⁶⁸ Shankar Acharya, 2001, "India's Macroeconomic Management during the Nineties"

⁶⁹ <http://in.news.yahoo.com/sc-notice-tata-motors-singur-land-065447558--finance.html>

⁷⁰ See India Human Development Report 2011. The HDI for Gujarat, in 2008, was 0.527 and it ranked 10th among Indian states. Kerala stood first (HDI: 0.790), Himachal Pradesh scored 0.652, Punjab 0.605, Maharashtra 0.572 and Haryana 0.552.

⁷¹ Atul Kohli 2004

Given the endemic market failures in technology development, private investors will need organized help to overcome obstacles to manufacturing such as capital scarcity, infrastructure constraints, regulatory inconsistencies and rigidities in labour markets . Industrial policy in both South Korea and Japan suggests that well-designed state interventions were responsible for promoting cost and quality-efficient production that facilitated technology and high value exports.⁷²

Box 1: The success story of the Indian Automobile Industry

Government facilitated the creation an appropriate ecosystem for India’s automobile industry. The industry was opened to foreign competition in the 1980s. The government formed a partnership with Suzuki in 1982, which led to setting up Maruti Udyog Limited (MUL). Private sector participation was restricted in the passenger car segment until the 1990s with only three major players – Maruti, Hindustan Motors and Premier Automobiles Limited. However, the commercial vehicle segment was liberalized and saw the rise of joint ventures such as DCM-Toyota; Allwyn-Nissan; and Eicher-Mitsubishi. Government funded training programmes and cluster building led to a change in supplier relations, enabling vendor development and effective supply chain management. Joint ventures with Japanese firms led to the creation of industrial agglomerations and adoption of Japanese practices such as cooperative agreements between suppliers and OEMs (Original Equipment Manufacturers).

Liberal policies allowed firms to invest in multiple product lines, which had been outlawed in the past by policy. Companies like Tata Motors introduced special purpose vehicles and platforms in order to enter the passenger car segment. Entry of new competitors led to spillover benefits, especially on the technology side. This also led to increased expenditure on R&D and a desire to innovate in order to distinguish products in the market. The time span between new products rapidly declined. Also, the institutional support for developing supplier capabilities led to the establishment of flexible supplier relationships which were very important. The industry benefited immensely from innovation and its spillovers, brought out through inter-firm collaborations.

Source: Interview with Professor Pradeep Dutta, IISC and Saripalle (2012)

4.3 India’s current policy environment for manufacturing

India’s recent tryst with manufacturing can be traced to the creation of the National Manufacturing Competitive Council (NMCC) in 2004. Recognizing the spill over benefits of manufacturing, NMCC was set up to advice the government on industrial and sector specific initiatives necessary to enhance the competitiveness of India’s manufacturing. It was however only with the National Manufacturing Policy (NMP 2011) that some clarity

⁷² Chan Wai-keung (Timothy),1999, “A comparative study on the industrial policy in Japan and South Korea”, University of HongKong

emerged.⁷³ There are some vital milestones in the NMP –to increase the share of manufacturing in GDP to 25 percent within a decade and create 100 million new jobs-but also importantly recognition of the challenges, namely the low levels of ‘value-addition’ in high skill and high technology sectors and increasing dependence on imports for electronics and capital goods. NMP rightly focuses on depth in manufacturing - to help attain long term competitiveness. The policy also emphasizes the need to build an indigenous value chain in sectors crucial to national security. National Investment and Manufacturing Zones (NIMZs) are seen in the NMP as massive industrial greenfield townships which will support world class manufacturing activities. Manufacturers, both large and small, can benefit from the ecosystem including quality infrastructure, advanced technology, efficient energy and high skill development facilities.

The NMP acknowledges the need to develop indigenous technological expertise but also the capacity to make vital technological acquisitions from other countries. Various incentives and schemes specially focus on promoting green technology adoption⁷⁴.

Other focus areas under the new policy include industrial training and skill upgradation. The policy estimates about 24.5 million additional job opportunities in the manufacturing sector during 2016-17. It also aims at creating a three tiered structure for skill development which includes vocational and skill training through establishment of ITIs (Industrial Training Institutes) in PPP mode, specialized skill development through establishment of Polytechnics and establishment of Instructor’s Training Centre in each NIMZ⁷⁵.

India’s 12th Five Year Plan (2012-17) also focuses on industrial policy and the need for improved competitiveness in the manufacturing sector. The policy suggests the need for active involvement of private enterprises and other non-governmental stakeholders with close coordination between producers and government policymakers.

Among other policies with a focus on manufacturing is the National Policy on Electronics (NPE) 2011 that acknowledges the need to transform India into a global hub for electronics system design and manufacturing (ESDM) *inter alia* to meet the rising domestic demand. In 2020, domestic demand is estimated to increase to USD 400 billion while the estimated production will be USD 104 billion, creating a gap of about USD 296 billion. Nurturing the electronics hardware industry is not only important from an economic perspective but also vital for national security and strategic reasons. The Science, Technology and Innovation policy (2013) is yet another initiative to push India’s industry towards high value manufacturing.

⁷³ http://dipp.nic.in/English/policies/National_Manufacturing_Policy_25October2011.pdf

⁷⁴ All buildings (more than 2,000 sqm built up area) in the NIMZ including industrial/institutional/commercial/residential which obtain green rating under the Indian Green Building Council (IGBC/LEED) or GRIHA systems will be eligible for an incentive of Rs.2 lakhs.

⁷⁵ Initiatives in this area would include setting up of institutes of specialized learning such as a specialized Polytechnic for the automobile sector, or a Polytechnic focused on high-tech manufacturing and semiconductors for the electronics sector, or one that fosters innovation and product development in the IT/ITES sector. These institutes will be a crucible for specialized skills in the workforce as well as for upgrading skills in the existing workforce.

While policies in India are fairly well formulated and embedded in the local context, implementation continues to remain a bugbear. The ability of the state to deliver on these several goals simultaneously depends on the quality implementation that is often politicized because of a variety of interests. Weak institutions and limited state capacity adds to the dilemma. For example, FDI in multi brand retail was recently permitted in India but it has been subject to several safeguards such as local sourcing from small and medium enterprises. The ability of the state to enforce this and other such conditions is at best doubtful. The need to create a Foreign Investment Implementation Authority (FIIA) to facilitate translation of FDI approvals into implementation is a reflection of the difficulty⁷⁶.

5. Conclusions and Recommendations

The need to create an eco-system for manufacturing to thrive, especially of high value products cannot be over emphasized. High value manufacturing (HVM) is an emerging area of economic research. Although the existing literature makes references to ‘high value’, there is no single definition that captures its meaning. This study has attempted to conceptualize HVM from two different perspectives, one that deals with value creation, including financial, social and strategic value and the other that focuses on enablers of value creation, namely skill and technology. In the absence of adequate data on measures of value creation in India, we focused on enablers using UNCTAD’s classification of products based on skill and technology intensity.

According to the secondary data analysis – HVM in India consists of pharmaceuticals, auto-components and chemical industries. There are islands of excellence in the HVM space and the cases studies highlight the role that innovation, skill and technology played in the transformation. Barring these fragmented growth stories, India lacks the dedicated focus for development of HVM. For example, despite the potential in electronics and IT hardware, manufacturing is close to absent in India. Imports fill the breach, while the limited manufacturers of electronics and IT hardware in India deal with several business challenges, discouraging private enterprise. Most countries can reach the core only if they “jump” over empirically infrequent distances in the product space.⁷⁷

The product space analysis confirms India’s poor performance in HVM compared to East Asian countries. According to the density analysis, India has the potential to rapidly develop comparative advantage in few products (especially in chemicals and pharmaceuticals) which need capabilities that already exist in India. However, there are product groups such as electronics and IT hardware that require serious government intervention and policy incentives. India’s absence from the Asian regional production networks is a manifestation of that weakness. The industry has therefore become a matter of serious concern for India - stated in several policies recently. Very recently, the Government has approved the proposal

⁷⁶ Foreign Investment Implementation Authority (FIIA) has been set up by the government of India in order to encourage the implementation of the proposals for FDI in the country. <http://dipp.nic.in/English/Investor/FIIA.aspx>

⁷⁷ Hidalgo, Klinger, Barabasi, and Hausmann, 2007, “The Product Space Conditions the Development of Nations”

of two industry consortiums to set up semiconductor fabs in India, reiterating the role of government intervention in promoting high value manufacturing in India. The performance of the electronics industry in India is in sharp contrast to that of auto and auto components that has significantly improved its competitiveness over the years. Factors inhibiting electronics and IT hardware manufacturing range from lack of policy focus, poor infrastructure, labour market rigidities and the all too familiar red tape.

HVM poses a serious challenge. A two pronged strategy is called for. Horizontal reforms that address the poor condition of infrastructure, labour market reform that focuses on flexibility, skill development that focuses on industry needs are well understood. Evidence from comparator nations shows the importance of basic infrastructure facilities that drive manufacturing. Promotion of industrial research and upgradation of skill are two other important factors across all industries. At the micro level, policies to promote select HVM industries in clusters are a viable option. India's size and diversity make it impossible to scale up immediately. Even in China SEZs proved instrumental in accelerating economic development. While SEZs do exist in India, poor implementation has detracted from generating the desired impacts. Lessons from the SEZ experience will perhaps make the proposed National Investment and Manufacturing Zones (NIMZs) more successful. This paper provides insight on which industry clusters are likely to generate the largest externalities immediately and in the long term.

Finally, a serious caveat to the findings from the product space analysis is the assumption that gross exports reflect a country's capabilities in manufacturing a product. Recent literature highlights the low levels of domestic value addition in certain country exports, suggesting that gross exports may overestimate a country's capability set. *Table 13 Appendix B* shows the total domestic value added in select industries for Japan, Korea, and China from the WIOD⁷⁸ database. According to these estimates imported value addition in China and Korea's exports of electrical and optical equipment is 29% and 37% respectively. These estimates reflect on the one hand, the rise of 'global manufacturing' and on the other, the acute competition facing firms to move up the value chain. However, for India, though imported value added is much lower, the level of gross exports is miniscule compared to that for China, Japan, and Korea. Product space analysis using value added in exports could be the next step to this research. Though the results on industrial/ manufacturing capabilities may be different due to emerging trends in global value chains, the broad conclusions on policy intervention to promote HVM in India will remain undisputed.

⁷⁸ World Input Output Database

APPENDIX A

Existing Industry Classifications and their shortfalls

International industry classifications are of broadly three types: those that classify economic activities; products and traded goods and services. The most commonly used classifications include the International Standard of Industrial Classification (ISIC); the Central Product Classification (CPC); and the Harmonized Commodity Description and Coding System (HS) and Standard International Trade Classification (SITC).

Existing internationally accepted industry classifications would be a natural starting point in assisting us in defining high value manufacturing. In fact, the International Standard of Industrial Classification (ISIC) which is maintained by the United Nations aims at providing a ‘consistent classification structure of economic activities based on a set of internationally agreed concepts, definitions, principles and classification rules’. Currently in its fourth version, the ISIC attempts to constantly reflect the current structure of the world economy and the complexity and interconnectedness that have come to characterize it. The criteria that are used to define categories in the ISIC are based on the inputs of goods, services and factors of production; the process and technology of production; the characteristics of outputs; and the use to which outputs are put. Moreover, these criteria are not watertight and a certain amount of flexibility is encouraged. At higher levels the characteristics of output and the use to which they are put become more important to create analytically useful aggregations.

Thus while current industry classifications, due to their frequent revisions, do take into account the changing nature and type of activities, they need to be supplemented for our purposes because, the categories of the ISIC do not provide a basis for distinguishing which manufacturing industry and or/product can potentially be high value manufacturing because they say nothing about the different forms of *outcomes created* and the factors that enable the creation of these outcomes. In fact the ISIC defines manufacturing to be ‘The physical or chemical transformation of materials, substances, or components into new products’⁷⁹. Manufacturing in other words is equated to production. There is thus a need to evolve a supplemental set of parameters, based on literature review that will enable us to identify which industries truly constitute high value manufacturing.

⁷⁹ The exception to this is the processing of waste which is classified separately in the ISIC

APPENDIX B

Table 1: Top ten ISIC industries in India in descending order of HVM Index value

<i>S. No.</i>	<i>4-digit ISIC Code</i>	<i>India</i>	<i>HVM Index</i>
1.	1711	Textile fibre preparation, textile weaving	7.20
2.	2710	Basic iron and steel	6.60
3.	1810	Wearing apparel, except fur apparel	5.00
4.	2423	Pharmaceuticals, medicinal chemicals etc	3.75
5.	3430	Parts/accessories for automobiles	3.26
6.	1600	Tobacco products	2.84
7.	1549	Other food products n. e. c.	2.67
8.	1542	Sugar	2.56
9.	1531	Grain mill products	2.14
10.	2520	Plastics products	1.93

Table 2: Top ten ISIC industries in China in descending order of HVM Index value

<i>S. No.</i>	<i>4-digit ISIC Code</i>	<i>China</i>	<i>HVM Index</i>
1.	2710	Basic iron and steel	67.95
2.	1810	Wearing apparel, except fur apparel	50.65
3.	3210	Electronic valves, tubes, etc.	33.58
4.	1711	Textile fibre preparation,; textile weaving	30.65
5.	2520	Plastics products	21.11
6.	1920	Footwear	19.47
7.	2899	Other fabricated metal products n. e. c.	16.97
8.	3000	Office and computing machinery	16.39
9.	3430	Parts/accessories for automobiles	16.29
10.	2720	Basic precious and non-ferrous metals	15.87

Table 3: Top ten ISIC industries in Japan in descending order of HVM Index value

<i>S. No.</i>	<i>4-digit ISIC Code</i>	<i>Japan</i>	<i>HVM Index</i>
1.	3430	Parts/accessories for automobiles	36.93
2.	3210	Electronic valves, tubes, etc.	15.27
3.	2520	Plastics products	15.07
4.	3230	TV and radio receivers and associated goods	14.71
5.	3410	Motor vehicles	14.47
6.	1549	Other food products n. e. c.	11.99
7.	2710	Basic iron and steel	10.30
8.	2929	Other special purpose machinery	9.85
9.	2221	Printing	9.24
10.	2922	Machine tools	7.05

Table 4: Top ten ISIC industries in Korea in descending order of HVM Index value

<i>S. No.</i>	<i>4-digit ISIC Code</i>	<i>Korea</i>	<i>HVM Index</i>
1.	3210	Electronic valves, tubes, etc.	12.00
2.	3511	Building and repairing of ships and boats	8.08
3.	3430	Parts/accessories for automobiles	7.93
4.	3410	Motor vehicles	7.49
5.	2520	Plastics products	5.33
6.	2710	Basic iron and steel	4.78
7.	3220	TV/radio transmitters; line comm. apparatus	4.12
8.	2929	Other special purpose machinery	3.54
9.	2915	Lifting and handling equipment	2.78
10.	3110	Electric motors, generators and transformers	2.76

Table 5: Top ten HS 6-digit high skill and technology intensive commodities in descending order of RCAs, India

Rank	HS 6-digit code	RCA	Description	ISIC Industry Code	ISIC Industry Description
1	290362	48.42	Hexachlorobenzene and DDT	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
2	290242	48.33	Xylenes - m-Xylene	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
3	294200	42.18	Cefadroxil & its salts, ibuprofane, nifedipine, ranitidine, danes salt of phenylglycine	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
4	330125	26.36	Of other mints	2429	Manufacture of other chemical products n. e. c.
5	290611	23.69	Cyclanic, cyclenic or cycloterpenic: Menthol	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
6	283190	22.70	Other Dithionites and sulphoxylates (excl. of sodium)	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
7	293929	22.24	Other alkaloids of cinchona and their derivatives	2423	Manufacture of pharmaceuticals, medicinal chemicals and botanical products
8	330190	19.85	Concentrates of essential oils in fats	2429	Manufacture of other chemical products n. e. c.
9	330124	18.77	Essential oils of pepper mint	2429	Manufacture of other chemical products n. e. c.
10	292142	18.69	Aniline derivatives and their salts	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds

Table 6: Top ten HS 6-digit high skill and technology intensive commodities in descending order of RCAs, China

Rank	HS 6-digit code	RCA	Description	ISIC Industry Code	ISIC Industry Description
1	283660	7.57	Barium carbonate	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
2	360410	7.44	Fireworks	2429	Manufacture of other chemical products n.e.c.
3	282710	7.35	Ammonium chloride	2412	Manufacture of fertilizers and nitrogen compounds
4	284180	7.31	Tungstates (wolframates)	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
5	293221	7.27	Coumarin, methylcoumarins and ethylcoumarins	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
6	291421	7.17	Camphor	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
7	294140	7.05	Chloramphenicol and its derivatives	2423	Manufacture of pharmaceuticals, medicinal chemicals and botanical products
8	291461	6.85	Antraquinone	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
9	293213	6.74	Furfuryl alcohol and tetrahydrofurfuryl alcohol	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
10	282919	6.72	Chlorates (excl. of sodium)	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds

Table 7: Top ten HS 6-digit high skill and technology intensive commodities in descending order of RCAs, Japan

Rank	HS 6-digit code	RCA	Description	ISIC Industry Code	ISIC Industry Description
1	392073	18.61	Sheet of cellulose acetate, non plasticized	2520	Manufacture of plastics products
2	290612	17.51	Cyclohexanol, methylcyclohexanols and dimethylc	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
3	370199	12.27	Photographic plates and film, in the flat (excl	2429	Manufacture of other chemical products n.e.c.
4	370120	12.20	Instant print flat film, unexposed	2429	Manufacture of other chemical products n.e.c.
5	340540	10.92	Scouring pastes and powders and other scouring	2424	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet prepara
6	910811	10.12	Watch movements, assembled, battery powered wit	3330	Manufacture of watches and clocks
7	320650	9.85	Inorganic products of a kind used as luminophor	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
8	391520	8.88	Waste, parings and scrap, of polymers of styrene	9999	Goods not elsewhere classified
9	290729	8.74	Other polyphenols, nes	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
10	370790	8.40	Chemical preparations for use, photograpic nes	2429	Manufacture of other chemical products n.e.c.

Table 8: Top ten HS 6-digit high skill and technology intensive commodities in descending order of RCAs, Korea

Rank	HS 6-digit code	RCA	Description	ISIC Industry Code	ISIC Industry Description
1	283719	15.77	Cyanides, cyanide oxides (excl. sodium)	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
2	291732	12.81	Dioctyl orthophthalates	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
3	283711	10.64	Cyanides and cyanide oxides of sodium	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
4	901380	10.25	Optical devices, appliances and instruments, ne	3320	Manufacture of optical instruments and photographic equipment
5	290230	10.02	Toluene	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
6	291736	9.77	Terephthalic acid and its salts	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
7	291735	9.45	Phthalic anhydride	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
8	283640	8.37	Potassium carbonates	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
9	390330	8.03	Acrylonitrile-butadiene-styrene (ABS) copolymer	2413	Manufacture of plastics in primary forms and of synthetic rubber
10	281520	7.52	Potassium hydroxide (caustic potash)	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds

Table 9: Top ten high skill and technologically intensive HS 6-digit products and their respective parent ISIC industry categories, in descending order of export shares, India (2011)

Rank	HS 6-digit code	Exports as a % of Total Exports	Description	RC A	ISIC Industry Category
1	300490	1.75	Other medicaments of mixed or unmixed products,	1.09	2423
2	852520	1.09	Transmission apparatus, for radio-telephony	1.12	3220
3	294200	0.85	Other organic compounds, nes	42.18	2411
4	880330	0.61	Aircraft parts nes	2.12	3530
5	390210	0.39	Polypropylene, in primary forms	3.16	2413
6	851790	0.31	Parts of electrical apparatus for line telephony	0.52	3220
7	300420	0.29	Cephalosporins and their derivatives:	2.83	2423
8	290243	0.26	p-Xylene	2.53	2411
9	380810	0.24	Insecticides, put up for retail sale	5.89	2421
10	290220	0.20	Benzene	4.08	2411

Table 10: Top ten high skill and technologically intensive HS 6-digit products and their respective parent ISIC industry categories, in descending order of export shares, China (2011)

Rank	HS 6-digit code	Export Shares	Description	RCA	ISIC Industry Category
1	847120	5.79	Digital auto data processing	6.20	3000
2	852520	3.33	Transmission apparatus, for radio -telephony	3.45	3220
3	851790	2.01	Parts of electrical apparatus for line telephony	3.32	3220
4	847330	1.58	Parts and accessories of automatic data process	2.09	3000
5	901380	1.56	Optical devices, appliances and instruments	3.26	3320
6	854211	1.51	Monolithic integrated circuits, digital	1.03	3210
7	854140	1.47	Photosensitive semiconductor devices, photovoltaic	3.25	3210
8	851730	1.34	Telephonic or telegraphic switching apparatus	2.42	3220
9	852810	1.17	Television receivers including video monitors a	2.06	3230
10	847193	0.84	Storage units	1.93	3000

Table 11: Top ten high skill and technologically intensive HS 6-digit products and their respective parent ISIC industry categories, in descending order of export shares, South Korea (2011)

Rank	HS 6-digit code	Export Shares	Description	RCA	ISIC Industry Category
1	854211	6.73	Monolithic integrated circuits, digital	4.59	3210
2	901380	4.92	Optical devices, appliances and instruments, ne	10.24	3320
3	852520	2.72	Transmission apparatus, for radio telephony	2.81	3220
4	851790	1.61	Parts of electrical apparatus for line telephony	2.66	3220
5	852990	1.49	Other parts used solely or principally with apparatus of headings 8525 and 8528	4.35	3230
6	847330	0.90	Parts and accessories of automatic data process	1.19	3000
7	291736	0.81	Terephthalic acid and its salts	9.77	2411
8	854140	0.70	Photosensitive semiconductor devices, photovolta	1.54	3210
9	390330	0.50	Acrylonitrile-butadiene-styrene (ABS) copolymer	8.03	2413
10	290243	0.50	p-Xylene	4.90	2411

Table 12: Top ten high skill and technologically intensive HS 6-digit products and their respective parent ISIC industry categories, in descending order of export shares, Japan (2011)

Rank	HS 6-digit code	Export Shares	Description	RCA	ISIC Industry Category
1	854211	2.17	Monolithic integrated circuits, digital	1.48	3210
2	854219	1.38	Monolithic integrated circuits, nes	1.46	3210
3	852530	1.02	Television cameras	4.10	3220
4	901380	0.93	Optical devices, appliances and instruments, ne	1.95	3320
5	854140	0.80	Photosensitive semi-conductor devices, including photovoltaic cells whether or not assembled	1.77	3210
6	382390	0.62	Chemical products and residual products of chemicals	2.10	2429
7	852990	0.62	Other parts used solely or principally with apparatus of headings 8525 and 8528	1.80	3230
8	381800	0.47	Chemical elements and compounds doped for use in electronics, in the form of discs, wafers, cylinders, rods or similar forms	5.34	2429
9	290243	0.47	p-Xylene	4.60	2411
10	900120	0.45	Sheets and plates of polarising material	8.15	3320

Table 13: Percentage of Imported Value Add in a country's exports for select industries (million USD)

Industry	Chemical and Chemical Products		Rubber and Plastics		Basic Metal and Fabricated Metal		Machinery		Electrical and Optical Equipment		Transport Equipment	
	Country	Total Exports	% of Imported Value Add	Total Exports	% of Imported Value Add	Total Exports	% of Imported Value Add	Total Exports	% of Imported Value Add	Total Exports	% of Imported Value Add	Total Exports
China	89736.3	0.22	54324.7	0.22	99319.8	0.25	118000	0.21	638982.3	0.29	79335.7	0.21
Japan	57476.4	0.18	29188.1	0.15	102658.6	0.21	81753.3	0.14	162860.6	0.15	174328.5	0.14
South Korea	46018	0.45	9568	0.36	42211.7	0.43	35225.8	0.34	147823.5	0.37	103353	0.32
India	17696.7	0.19	4115.92	0.19	24733.5	0.19	9077.2	0.19	23993.5	0.19	19227.4	0.20

Source: WIOD

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