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Exports, capabilities, and industrial policy in India

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ABSTRACT

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An extensive literature argues that India's manufacturing sector has underperformed, and that the country has failed to industrialize; in particular, it has failed to take advantage of its labor–abundant comparative advantage. India's manufacturing sector is smaller as a share of GDP than that of East Asian countries, even after controlling for GDP per capita. Hence, its contribution to overall GDP growth is modest. Without greater participation of the secondary sector, the argument goes, the country will not be able to develop and become a modern economy. Standard arguments blame the "*license-permit raj*", the small-scale industrial policy, and the labor laws. All these were part of the industrial policy regime instituted after independence. This regime favored the heavy-machinery subsector. We argue that despite its shortcomings and misallocations, the bias towards machinery, metals, chemicals, and other capital- and skilled labor-intensive products allowed Indian manufacturing to accumulate a wide range of capabilities. We show that India's manufacturing sector is more diversified and sophisticated than one would expect given the country's income per capita. This positions India well to continue expanding its exports of other sophisticated products. India's failure, however, lies in not being able to diversify into labor-intensive sectors and generate the type of structural transformation seen in China. *Journal of Comparative Economics* **41** (3) (2013) 939–956. Asian Development Bank, Levy Economics Institute of Bard College, NY, USA.

1. Introduction

A key stylized fact in the development literature is that manufacturing is a key driver of growth. Indeed, the importance of industrialization, and in general structural transformation, as the key to develop was highlighted by Kaldor (1967) and emphasized recently by Rodrik (2006). In this framework, the manufacturing sector assumes a central role in the growth process, thanks to its ability to generate spillovers; and its potential for capital accumulation, technical progress, economies of scale, induced productivity growth in the sector, and capacity to raise the overall productivity of the economy. For these reasons, Kaldor argued that manufacturing is the "engine of growth", in the sense that the faster the rate of growth of manufacturing output, the faster the rate of growth of overall output (GDP).[1] A second stylized fact in development is that the

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[1] Felipe et al. (2009) estimate the responsiveness of the rest of the economy's growth rate to growth in the individual sectors of the economy. Their estimates show that, in developing Asia, both industry and services have acted as engines of growth, and that services has had a larger impact than manufacturing. The reason is that many of today's services are also subject to increasing returns to scale.

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share of the manufacturing sector in overall output increases with income per capita before it starts declining, i.e., an inverted U-shape relationship (Chenery and Taylor, 1968; Felipe and Estrada, 2008).

In India—despite the early emphasis on industrialization after independence and deregulation of the manufacturing sector as a key element of the reforms implemented since the mid-1980s—large-scale industrialization, as seen in East Asia, has not happened. Indeed, one of the salient features of India's economic structure is the relatively low share of the manufacturing sector in GDP, about 15%, and it has not changed much over the last 30 years. This share is significantly smaller than that in the East Asian countries, and much smaller than China's, where the share of manufacturing in GDP is about 35%. Using a logistic regression and controlling for income per capita and its square, population, and the share of trade in GDP ratio, Felipe and Estrada (2008) estimated that India's manufacturing share is about five percentage points smaller than it should be. Several reasons have been discussed in the literature for the underperformance and the relatively small size of the manufacturing sector in India. These include the industrial policy framework adopted in the early days of planning, along with the industrial and import licensing regime, the small-scale sector reservation policy, the rigid labor laws, and the lack of physical and social infrastructure.

The relatively high growth achieved by India recently has come largely from the service sector, which has emerged as the main driver of growth, and has contributed an increasing share of the country's overall growth rate: services contributed 50% of the overall growth during 1980–1990, 61% during 1990–2000, and 64% during 2000–2007.[2] The information technology (IT) sector has become a leading sector in India during the last decade. The IT sector was outside the ambit of the licensing system and did not suffer from regulation and control of its activities to the extent that the manufacturing sector did.

Under the development strategy adopted after independence, the public sector was assigned the role to lead India's industrial development, with an emphasis on the heavy machinery sector. Labor-intensive products were reserved exclusively for small-sized units under the small-scale industries reservation policy.[3] The idea was to protect these sectors from competition from larger units so that they could generate employment in a labor–abundant country. Kochhar et al. (2006) argue that on the eve of the reforms, India's policy stance with respect to the manufacturing sector was biased in favor of the skilled labor-intensive or large-scale activities, and that the manufacturing sector was more diversified than would be expected given India's income level. They found that this pattern persists even after 20 years of significant reforms. This, they argue, has been the result of a policy regime that has protected small-scale industries, made it hard to lay-off workers in firms above a certain size, restricted imports if something could be produced domestically irrespective of cost, and promoted higher education and scientific learning.

Viewing development as a path-dependent process that involves structural transformation and the accumulation of capabilities, this paper contributes to the debate on the effects of industrial policy in India by providing a positive analysis. To this purpose, we examine the composition of exports at a highly disaggregated level and focus on two different aspects of the export basket, namely, its sophistication and its diversification. The sophistication level of the export basket of a country captures its ability to export products produced and exported by the rich countries to the extent that, in general, the exports of rich countries embody higher productivity, wages, and income per capita. Diversification, on the other hand, captures the ability to become competitive in a wider range of products and is measured by the number of products exported with revealed comparative advantage (RCA). Hidalgo et al. (2007) argue that development must be understood as a process of accumulating more complex capabilities and of finding paths that create incentives for those capabilities to be accumulated and used. A sustainable growth trajectory must, therefore, involve the introduction of new goods and not merely involve continual learning on the same of set goods.

Using highly disaggregated SITC 4-digit data for 1962–2007 covering almost 800 product categories, we find that India was a positive outlier on both sophistication and diversification, i.e., India's export basket was more sophisticated and diversified than would be expected for a country at its stage of development. Further, we find that the diversification and sophistication of "core" products (metals, machinery, and chemicals) was above what one would expect given India's per capita income. We also find that the share of core products in total manufacturing products exported with revealed comparative is relatively high. In other words, a labor–abundant country like India, whose comparative advantage lies in labor-intensive activities, has diversified in the skill-intensive and capital-intensive sector. We argue that this is a legacy of India's industrial policy, despite all its shortcomings and failures. We find that the number of labor-intensive products exported with RCA as a share of total manufacturing products exported with RCA is below what would be expected for a country at India's level of development. This where India lags vis-à-vis China, and the reason, at least partly, why it has not seen structural transformation at the scale it has happened in China.

The rest of the paper is organized as follows. In Section 2 we discuss India's industrial policy landscape. Section 3 examines the evolution of both the sophistication and diversification of India's export basket, and compares them to those of China. We also discuss the performance of the labor-intensive sectors and analyze India's progression into sophisticated products. Section 4 provides a discussion of the key findings. Section 5 summarizes the arguments.

[2] Dasgupta and Singh (2005) have argued that the services sector in India, especially the information and communication technology (ICT) sector, have the potential to play the same role, in a Kaldorian sense, as the manufacturing sector. Eichengreen and Gupta (2010) argue that sustained economic growth will require shifting labor from agriculture into both manufacturing and services. Panagariya also (2008: 287) argues that "India must walk on two legs", manufacturing and services. On the other hand, Nagaraj (2006) argues that services cannot become an engine of growth in India because they lack the potential to create the jobs needed to absorb the vast labor pool from the rural areas. This role, he argues, has traditionally been performed by the industrial sector.

[3] The original legal framework is provided by the Industries Development and Regulation Act of 1951.

2. A brief overview of india's industrial policy landscape and major reforms

The key objective of India's new leadership after independence was to be self-sufficient in all sectors of the economy. The early days of policymaking were heavily influenced by the Nehru–Gandhi ideology, which leaned towards a socialist framework and was influenced by contemporary academic thinking, e.g., Rosenstein-Rodan (1943), Scitovsky (1954) and, especially, Mahalanobis (1963). The development strategy aimed at achieving self-sufficiency, industrializing, improving living standards, reducing the concentration of economic power, and attaining balanced regional development and an equitable distribution of the gains from economic growth. The planned economy model adopted was largely inspired by the Soviet-style "command and control" system. A key difference was that while the means of the production in the Soviet Union were owned by the state, in the case of India a large share of the economy was privately owned. To plan the private economy, a system of controls and regulatory regimes was adopted.[4]

The key legislation on industrial development included the Industrial Policy Resolution of 1948; the Industries Development and Regulation Act (IDRA), 1951; the First and the Second Five Year Plans; and the Industrial Policy Resolution of 1956.[5] The industrial policy resolutions of 1948 and 1956, and the first and second five-year plans gave a central role to the public sector. The public sector was entrusted to lead the development and expansion of India's heavy machinery sector (i.e., to "make machines that make machines") and overall industrialization. An active role of the public sector in industrial development, it was hoped, would also foster an equitable distribution of income and wealth, balanced regional development, prevent concentration of wealth, create employment opportunities, and generate resources for further development.

Private sector activity was allowed, though the sectors in which it could operate were restricted. The key piece of legislation was the Industries (Development and Regulation) Act of 1951. The key aim of this Act was to regulate and control private sector activity in conformity with the government's priorities, as noted in the 5-year plans, and to direct scarce resources to industries considered important. To reduce dependence on foreign exchange and achieve self-reliance, import substitution was encouraged. Trade restrictions in the form of import licensing and tariffs were introduced. Importing anything that could be produced domestically was discouraged regardless of the cost, and exporters were allowed to import inputs under various schemes. A first key instrument introduced to achieve these objectives was a peculiar system of industrial licensing and import licensing system, known as the *license-permit raj*. Industrial licensing applied to any industrial undertaking above a certain size in a set of specified industries. No additional capacity expansion in the existing industrial undertakings (or new undertakings) was allowed in these scheduled industries. The license specified the minimum and the maximum quantity that could be produced. The government could dictate the location and the scale of the plant.[6] The industrial licensing regime was tightened over time and its reach widened.[7] This system, which led to inefficiencies, created a culture of rent-seeking, erected barriers to entry and exit, provided indiscriminate and indefinite protection, led to misallocation of resources, and limited domestic and foreign competition (Ahluwalia, 1991; Bhagwati and Srinivasan, 1975; Joshi and Little, 1994; Panagariya, 2008). Distribution and price controls were used to ensure that priority sectors received inputs at "reasonable" prices and to keep inflation in check. To avoid concentration of economic power in the hands of a few large industrial houses, the Monopoly and Restrictive Trade Practices Act (MRTP), 1969, and the Foreign Exchange Regulation Act (FERA), 1973, were introduced. These laws and regulations imposed severe constraints on the expansion of large business houses and discouraged foreign collaboration and investment.

Second, labor-intensive small-scale enterprises, cottage industries, and household enterprises were promoted by protecting them against foreign and domestic competition, and by providing them with supportive measures such as preferential access to credit and subsidized credit. A key element of this policy, the Small-Scale Industrial (SSI) Policy, was introduced in 1967, whereby the production of some products was reserved exclusively to the small-scale sector (defined in terms of cumulative amount of investment in plant and machinery). Once a product was classified to be produced by the small-scale sector, no further capacity expansion was permitted for medium- or large-scale units, though they were allowed to produce. All further expansion or capacity creation was reserved only for the small-scale sector and only those firms that had investment limits below the threshold could produce items reserved for the SSI. Mohan (2002) provides a comprehensive discussion and a critical evaluation of the small-scale industry policy in India. He concludes that these policies have been harmful for the growth of the Indian manufacturing sector.

A third aspect that has received considerable attention in the literature is India's labor laws. Significant job protection was accorded to workers, especially to those employed in large firms. A 1976 amendment to the Industrial Disputes Act of 1947 (IDA) made it necessary for firms employing more than 300 workers to seek the permission of relevant state governments in order to retrench or lay off workers. The reach of this expanded when a further amendment in 1982 lowered the ceiling to

[4] Mohan and Aggarwal (1990) note that the origins of the control and the regulatory regime can be traced back to the measures that were put in place at the beginning of World War II.

[5] The literature on India's development strategy after independence is voluminous. For reasons of space, we discuss only important legislations and their key aspects. More detailed accounts can be found in Bhagwati and Desai (1970), Bhagwati and Srinivasan (1993), Joshi and Little (1994 and 1996), and Panagariya (2008).

[6] Industrial undertaking was defined as any undertaking carrying out an activity pertaining to any of the industries in the First Schedule of the Act in one or more factories. Provisions of IDRA (1951) applied to a "factory" which under the Act was defined as any premises where manufacturing activity was being carried out with by 50 or more workers with power or by 100 or more workers and without power. (Source: http http://business.gov.in/legal_aspects/industries_act.php).

[7] Key policy enactments included the Industrial Licensing Policy of 1970, and two industrial policy notifications dated February 2nd and 19th, 1973.

firms with more than 100 workers.[8] These labor laws, by preventing restructuring and reallocation of resources, an unintended outcome of the labor laws has been that Indian firms have chosen to remain small (Kochhar et al., 2006; Krueger, 2007; Panagariya, 2008).[9]

Most aspects of the license–permit raj were in place until the 1980s, when the first steps were taken to dismantle the licensing regime. Among other steps, these reforms included the abolition of the licensing regime for select industries and the liberalization of the trade regime (via reductions in the number of products listed under banned/restricted category).[10] The second, and by all accounts the major, wave of reforms came in 1991. The New Industrial Policy announced in July 1991 extended industrial deregulation, in both its coverage and depth, beyond what had been achieved in the 1980s. These measures included the abolition of industrial licensing for all but 18 industries, elimination of public sector monopolies together with easing of restrictions on private investment in these industries (industries restricted to the public sector were reduced to 8 from 17), and relaxation of foreign direct investment rules. While there was an upper limit on the extent of foreign participation, this varied across industries and has increased over the period. Sweeping trade liberalization measures were also introduced. These included the elimination of import licensing and the progressive reduction of tariff and nontariff barriers. The export–import policy (EXIM policy) of 1992–1997 reaffirmed India's commitment to the promotion of free trade. All import licensing lists were eliminated and a "negative" list was established.[11] Except for consumer goods, almost all capital and intermediate goods could be freely imported subject to tariffs. By April 2002, all the remaining quantitative restrictions had been removed. Reforms were undertaken in the banking and the financial sectors as well. Liberalization measures were taken in important services such as telecommunications. De-reservation of the small-scale sector began only in 1997 and the total number of products reserved for the small-scale sector had been reduced from 821 in 1998–1999 to 21 items in October 2008.[12]

Overall, it is virtually impossible to make an assessment of India's industrial policy record. Bardhan (2006), for example, argues that policy alone is not what has held back the manufacturing sector, but also the lack of physical and social infrastructure. And moreover, the period 1965–1975 was plagued with economic and political shocks, including the effects of the war with China in 1962, the two wars with Pakistan in 1965 and 1971 (and the suspension of foreign aid following these wars), drought in the late 1960s, and the devaluation of the rupee following the first oil shock (Singh, 2010). These events make an unbiased assessment of India's industrial policy almost impossible.

3. Sophistication and diversification of India's export basket

In this section, we analyze how the sophistication and diversification of India's export basket has evolved since the 1960s. We focus particularly on the labor-intensive categories (the negatively affected sector by the country's history of industrial policy) and on the machinery groups (the objective of the architects of the country's industrial policy). We use a highly disaggregated data set covering almost 800 products. We analyze both the overall export basket as well as the core products. For details, see data Appendix A.

The sophistication of a country's export basket (EXPY) is calculated as the weighted average of the level of sophistication of the products (PRODY) that it exports (for the calculation of EXPY and PRODY, see data Appendix A). Following Hidalgo et al. (2007), diversification is measured by the absolute number of products that a country exports with revealed comparative advantage. The measure of revealed comparative advantage (RCA) used here is that proposed by Balassa (1965). RCA is measured as the ratio of the export share of a given product in the country's export basket to the share of that product in total world exports. A country has revealed comparative advantage in a product if its RCA is greater than 1. Balassa (1965) argues that "comparative advantage appears to be the outcome of a number of factors, some measurable, others not, some easily pinned down, others less so". In other words, comparative advantage in a product is due to a multiplicity of factors. If $RCA > 1$, then the country is "good" at exporting that product. This (i.e., $RCA > 1$) reflects relative costs as well as non-price factors. To capture diversification, we calculate the products that a country is "good" at exporting. Using the number of products with $RCA > 1$ (and not al l products that a country exports) allows us to do that.

[8] Though the IDA does not prohibit retrenchments, state governments have often been unwilling to grant permission to retrench (Datta-Chaudhari, 1996).

[9] Roy (2004) finds that the impact of labor laws is statistically insignificant in a regression explaining the underperformance of the manufacturing sector. Using case studies of labor practices, Deshpande (2004) concludes that India's labor market is not as inflexible as claimed. Using World Bank's investment climate survey data on Indian states, labor regulations do not show up as a significant concern for enterprises (Gupta et al., 2010). Kochhar et al. (2006) and Krueger (2007) argue that this could be because the incumbent firms have adapted to these laws and it is hard to say what decisions those firms would have made in their absence, i.e., lack of an appropriate counterfactual. Moreover, these laws affect investment decisions of the new entrants, who may choose a more capital-intensive, skilled-labor line of production or technology. Other recent studies on the role played by labor laws use differences in what are presumed to be rigid labor laws across states to test whether industrial performance has been weaker in states with seemingly pro-worker labor laws (Besley and Burgess, 2004); and to test the effect from de-licensing in pro-worker labor laws (Aghion et al., 2006). Gupta et al. (2009) show that states with relatively inflexible labor laws experienced slower growth of labor-intensive industries and slower employment growth.

[10] For further details, see Panagariya (2008).

[11] The establishment of a "negative" list implied that all items, except those in the negative list, could be imported without any import licenses and were not subject to any quantitative restrictions. The negative list consists of three sections: prohibited list, canalized items, and restricted list.

[12] http://commerce.nic.in/pressrelease/pressrelease_detail.asp?id=2325.

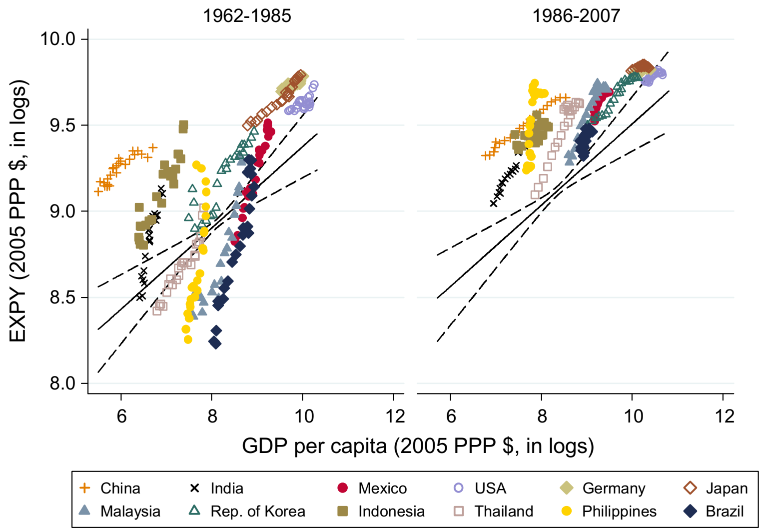

Fig. 1. Export Sophistication and GDP per Capita, 1962–2007. *Source*: UNCOMTRADE, WDI, and authors' estimations. *Notes*: EXPY is the sophistication level of a country's exports. The solid line is the estimated regression corresponding to Eq. (1); the dotted line is the 95% confidence interval. The scatter plot shows the actual EXPY data (on the *Y*-axis) for different countries.

3.1. Sophistication

To understand changes in the sophistication level of a country's export basket in the course of development, we examine its evolution across countries and over time. We estimate a regression of the log of EXPY on the log of GDP per capita. We also control for period dummies.

Specifically, the relationship estimated is the following:

$$\ln(EXPY_{jt}) = \alpha_0 + \alpha_1 \ln(GDPpc_{jt}) + \delta_t(\text{dummy}1986-2007) + \varepsilon_{jt} \tag{1}$$

where j is country and t is year from 1962 to 2007, and dummy for 1986–2007 takes value 1 if for the years 1986–2007 and 0 otherwise; 1962–1985 is the omitted category. Country-specific characteristics are controlled using dummy variables.[13] GDPpc is GDP per capita measured in 2005 PPP$. The notation is the same for all the equations. For the list of countries included in the estimation sample, see data Appendix A.[14] The coefficients of GDP per capita and of the period dummy variable are statistically significant at the 1% level. Higher powers of ln(GDPpc) and their interactions with the dummy variable for 1986–2007 were found to be statistically insignificant and hence were not included.

Fig. 1 shows the expected level of export sophistication given a country's level of development (proxied by its GDP per capita). The figure shows that India's export sophistication in the early 1960s, though within the 95% confidence interval, was higher than that of countries such as Thailand, Brazil, or Malaysia. However, post-1970s, the level of sophistication of India's export basket was significantly above what would be expected for a country at a similar stage of development. To give an example, India's average export sophistication for the period 2001–2007 ($12,005) is not significantly different from that of Brazil ($12,836) or that of Turkey ($12,549). The latter two, however, have much higher per capita incomes. To stress the significance of this point, note that the per capita income of today's rich countries when they had similar levels of export sophistication as India in 2007 was much higher. For example, Korea's EXPY in 1985 was comparable to that of India in 2007, but at three times the per capita income (Korea's per capita income in 1985 was $7500 and India's per capita income in 2007 was $2600).

Another way of examining the sophistication of India's export basket is to look at the sophistication of the core commodities only. We call this EXPY-core. This is calculated the same way as overall EXPY, except that the set of commodities over which sophistication is measured is restricted to what we refer to as "core commodities": machinery, chemicals, and metals. Core commodities are more sophisticated (i.e., higher PRODY) than non-core. The average PRODY of core commodities is $18,687, and that of those outside the core is $11,634 (these are averaged from the PRODYs of 779 4-digit SITC products).[15]

[13] In all the estimations reported in the paper, country-specific characteristics are controlled for by using country dummy variables. Hence, this is not noted subsequently in reference to each equation.

[14] Unless otherwise noted, countries included in the estimation sample are the same throughout the paper. The sample size, however, depending on the specific left hand side variable, may vary from one equation to another.

[15] The average sophistication of the various Leamer (1984) categories (see Appendix Table A.1) is as follows: petroleum, $15,446; raw materials, $10,934; forest products, $14,971; tropical agriculture, $8441; animal products, $12,390; cereals, $8794; labor-intensive, $13,170; capital-intensive (excluding metal products), $12,459; metal products, $14,964; machinery, $19,205; and chemicals, $19,517.

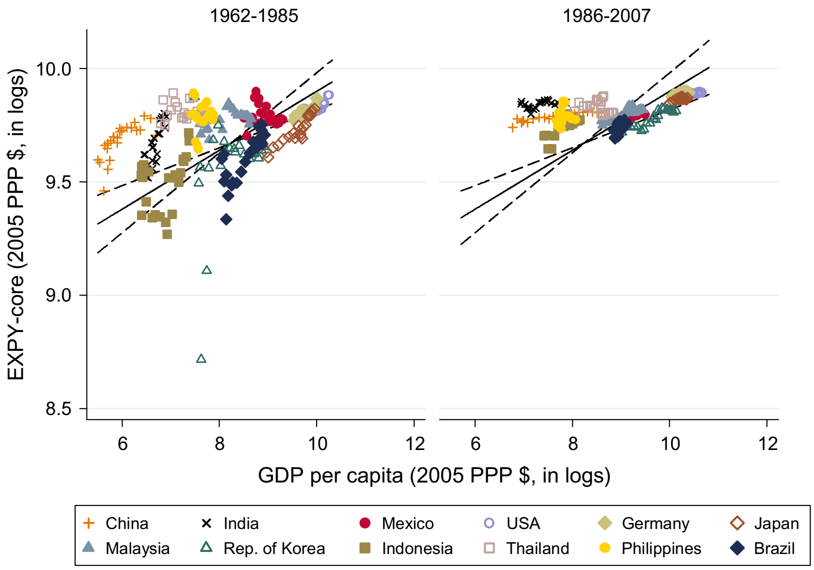

Fig. 2. Export sophistication of the core and GDP per Capita, 1962–2007. *Source*: UNCOMTRADE, WDI, and authors' estimations. *Notes*: EXPY-core is the sophistication level of the core products. Core products include metal products, machinery, and chemical (see Appendix Table A.1). The solid line is the estimated regression corresponding to Eq. (2); the dotted line is the 95% confidence interval. The scatter plot shows the actual EXPY-core data (on the *Y*-axis) for different countries.

To examine the sophistication level of India's core exports, given its income per capita, we estimate a regression of log of EXPY-core on the log of GDP per capita. The following equation is estimated:

$$\ln(EXPY - core_{jt}) = \alpha_0 + \alpha_1 \ln(GDPpc_{jt}) + \varepsilon_{jt} \tag{2}$$

The dummy variable for 1986–2007 in this case was found to be statistically insignificant, and hence only the log of GDP per capita was included. The countries included are the same as before. Higher powers of ln(GDPpc) and their interactions with the dummy variables were found to be statistically insignificant and hence not included. The coefficient on log of GDP per capita is statistically significant at the 1% level. Fig. 2 shows the relationship estimated in Eq. (2). The figure shows that India's core exports have, for the most part, been either as sophisticated or more sophisticated when compared with the core exports of comparator countries such as Brazil, China, Indonesia, Malaysia, Mexico, and Thailand. India lies outside the 95% confidence interval, i.e., India's core exports are more sophisticated than what would be expected given its level of development. Also from Fig. 2 we see that, in general, core exports of the high-income countries are more sophisticated. The average sophistication level of India's core exports ($18,955) during 2001–2007 is similar to that of France ($19,300), Japan ($19,288), Spain ($19,258), Hong Kong ($18,750), Australia ($18,665), and Korea ($18,308). These countries, however, have a much higher income per capita than India.

3.2. Diversification

A key insight from Hidalgo et al. (2007) is that the more diversified a country is, the greater its capabilities, which allows it to acquire RCA in other products. Table 1 shows the number of products India exported with RCA according to the Leamer (1984) classification over the period 1962–2007. We see that in 1962, out of a total of 71 products that India exported with RCA, only four (i.e., less than 6% of the total) were in the core. Animal products, cereals, and capital-intensive products (excluding metals) added up to 44 products. By 1980, the number of products that India exported with RCA had more than doubled to 157. Of the 157 products, 38 were core commodities, roughly a quarter of the total. This indicates that, on the eve of the reforms, India had accumulated significant capabilities in the core commodities.

Over the next 27 years, India acquired RCA in an additional 97 products (in net terms).[16] In 2007, out of the 254 products exported with RCA, 84 were in the core (representing one-third of the total). Of the 97 additional products in which India had gained RCA between 1980 and 2007, 46 were in the core (6 in metal products, 16 in machinery, and 24 in chemicals). The other category that registered a significant increase in the number of products exported with RCA was the capital-intensive products

[16] Between 1980 and 2007, India also lost revealed comparative advantage in some products. 97 is the net increase in the number of products exported by revealed comparative advantage between 1980 and 2007. The net gain is the difference between the number of (new) products in which India acquired revealed comparative advantage and the number of (old) products in which India lost revealed comparative advantage.

Table 1
India's export diversification according to Leamer classification. *Source*: UNCOMTRADE, WDI, and authors' estimations.

	1962	1965	1970	1975	1980	1985	1990	1995	2000	2005	2006	2007
Petroleum	1	1	1	0	0	1	1	1	2	1	1	1
Raw materials	8	7	9	10	8	10	14	15	14	22	25	25
Forest products	0	2	2	2	2	2	1	2	2	2	2	2
Tropical agriculture	7	8	12	10	12	10	11	11	14	13	18	17
Animal products	13	11	13	11	15	14	8	9	13	13	14	14
Cereals	13	14	12	13	19	20	23	25	19	24	27	28
Labor-intensive	7	7	12	32	30	28	29	34	37	39	37	36
Capital-intensive (exc. Metals)	18	21	20	28	33	29	37	44	41	45	44	47
Core commodities												
Metal products	1	3	11	12	15	10	13	21	21	21	19	21
Machinery	1	2	4	9	12	17	14	12	14	22	23	28
Chemicals	2	3	6	9	11	11	27	28	37	30	34	35
Total	**71**	**79**	**102**	**136**	**157**	**152**	**178**	**202**	**214**	**232**	**244**	**254**

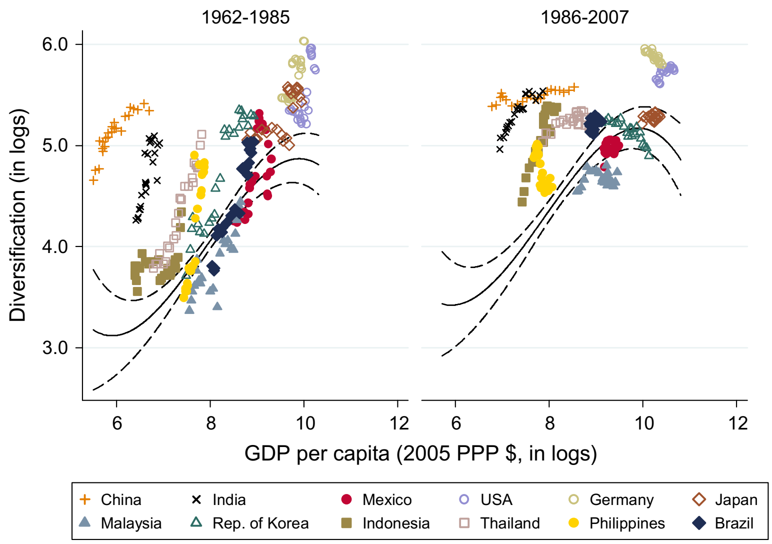

Fig. 3. Diversification and GDP per Capita, 1962–2007. *Source*: UNCOMTRADE, WDI, and authors' estimations. *Notes*: Diversification is the number of products exported with RCA. The solid line is the estimated regression corresponding to Eq. (3); the dotted line is the 95% confidence interval. The scatter plot shows the actual diversification data (on the *Y*-axis) for different countries.

(excluding metals). The number of products exported with RCA in this category increased by 14 (again in net terms), an increase largely due to the textiles sector, which saw an increase of 12 products.

We stress six points regarding diversification. The first concerns the product composition. Between 1962 and 1980, there was a net gain in the number of products exported with RCA in the labor-intensive categories, capital-intensive products, metal products, machinery, and chemicals, with labor-intensive products accounting for a quarter of the increase. Between 1980 and 2007, core sectors accounted for approximately half of the net gain in the number of products exported with RCA. As noted above, there was net gain in capital-intensive and raw materials as well. The labor-intensive sector did not see any major net gains in the post-reform period.

Second, we examine how diversification changes with income per capita. We estimate a regression of the log of diversification on the log of GDP per capita, its square, and its cube. Period dummy for 1986–2007 is also included. The relationship estimated is the following:

$$\ln(Diversification_{jt}) = \alpha_0 + \alpha_1 \ln(GDPpc_{jt}) + \alpha_2(\ln(GDPpc))^2 + \alpha_3(\ln(GDPpc))^3 + \delta_t(\text{dummy1986} - 2007) + \varepsilon_{jt} \tag{3}$$

The coefficients of all the terms included in Eq. (3) are statistically significant at the 1% level. Fitted values from Eq. (3) along with the actual values are shown in Fig. 3. We find that India's diversification is greater than that of comparator countries such as Indonesia, Korea, Malaysia, Mexico, and Thailand. Further, given its stage of development, the number of products in which India has RCA > 1 is significantly higher than what would be expected (shown by the fitted values).

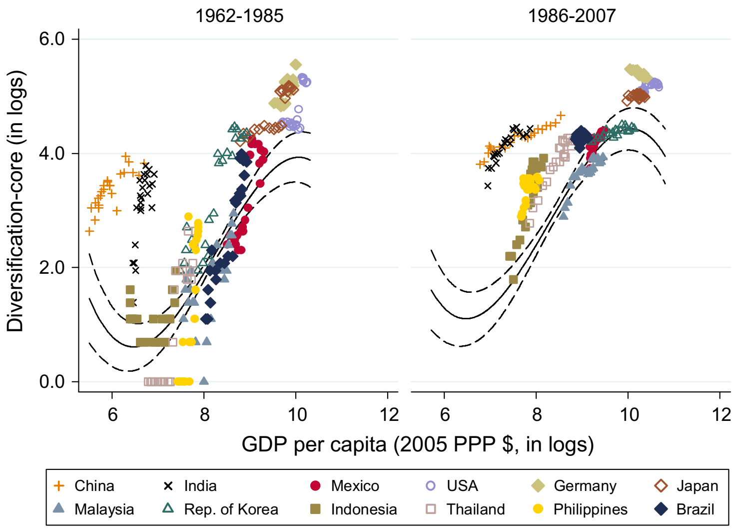

Fig. 4. Diversification in the Core and GDP per Capita, 1962–2007. *Source*: UNCOMTRADE, WDI, and authors' estimations. *Notes*: Diversification-core is the number of core products exported with RCA. Core is defined to include metal products, machinery, and chemical (Appendix Table A.1). The solid line is the estimated regression corresponding to Eq. (4); the dotted line is the 95% confidence interval. The scatter plot shows the actual diversification-core data (on the *Y*-axis) for different countries.

Third, during the period 2001–2007, China and India exported 257 and 246 products with RCA > 1, respectively.[17] Except for Indonesia (which exported 213 products with RCA > 1) and Thailand (197 products), no other lower-middle income had RCA > 1 in so many products. Other countries that were as diversified were either upper-middle income or high-income countries. Korea, for example, had RCA > 1 in 154 products during the period 2001–2007. Brazil and Russia, both upper-middle income countries, exported with RCA > 1, 190 and 105 products, respectively.

Fourth, in Fig. 4 we compare how diversification in the core evolves with per capita income. Like with overall diversification, we estimate a regression of the log of diversification in the core on the log of GDP per capita, its square, and its cube. Also included is the dummy for the period 1986–2007. We estimate the following equation:

$$\ln(Diversification - core_{jt}) = \alpha_0 + \alpha_1 \ln(GDPpc_{jt}) + \alpha_2(\ln(GDPpc))^2 + \alpha_3(\ln(GDPpc))^3 + \delta_t(\text{dummy1986} - 2007) + \varepsilon_{jt} \tag{4}$$

The estimated coefficients of all the terms included in Eq. (4) are statistically significant at the 1% level. The relationship estimated in Eq. (4) is shown in Fig. 4. It shows that not only did India export a larger number of core products with RCA > 1 than other comparator countries, but was also exporting a significantly higher number of core products with RCA than would be expected for a country at its stage of development (as shown by the fitted values). During 2001–2007, on average, India exported 81 core products with RCA > 1, while China exported 89.[18] Among the lower-middle income countries that exported a large number of core commodities with RCA > 1 are Ukraine (73), Thailand (68), and Indonesia (45). Other countries that exported as many core products with RCA > 1 are either high-income countries or upper-middle income countries. For the high-income countries (i.e., OECD) it is not uncommon to export over 100 core commodities with RCA > 1. Indeed, the average number of products exported with RCA > 1 in the core for the high-income OECD countries is 105.

Fifth, it is important to make a comparison with China. Table 2 shows China's export diversification over 1962–2007. Over this period, China increased the number of products exported with RCA > 1 from 105 to 265, and in the core increased from 14 to 106. The highest number of commodities that China exports with RCA > 1 is in the labor-intensive category. In China, the majority (39 out of 60 in 2007) of the machinery products exported with RCA > 1 are office and data processing, telecommunications, electrical, and photographic equipment. On the other hand, in India, the largest share (16 out of 28 in 2007) of machinery products exported with RCA > 1 are the power generating, machinery specialized for particular industries, metalworking, and general industrial machinery. Another interesting feature of China's progression is that it lost exports with RCA > 1 in categories such as tropical agriculture, animal products, and cereals, and gained exports with RCA > 1 in labor-intensive, capital-intensive, and core commodities. The speed at which China gained products with RCA > 1 in the machinery category is notable, from 3 in 1980, to 22 in 1990, to 60 in 2007.[19]

[17] The number of products noted here is the average number of products that a country exported with revealed comparative advantage during 2001–2007. It does not mean that China had revealed comparative advantage in the same 257 products in each year during 2001–2007.

[18] The number of products noted here is the average number of core products that a country exported with revealed comparative advantage during 2001–2007. It does not mean that India had revealed comparative advantage in the same 81 core products in each year during 2001–2007.

[19] For an in-depth analysis of China, see Felipe et al. (2012).

Table 2
China's export diversification according to Leamer classification. *Source*: UNCOMTRADE, WDI, and authors' estimations.

	1962	1965	1970	1975	1980	1985	1990	1995	2000	2005	2006	2007
Petroleum	0	1	1	1	5	3	2	1	2	1	2	1
Raw materials	9	8	7	10	13	11	15	14	16	11	11	11
Forest products	3	6	5	4	5	3	4	7	6	7	7	7
Tropical agriculture	15	23	25	23	20	17	15	15	15	10	10	8
Animal products	18	24	22	28	27	22	21	19	15	9	9	8
Cereals	13	20	24	21	21	31	27	14	16	9	8	8
Labor-intensive	18	22	32	36	49	44	60	59	63	69	69	68
Capital-intensive (exc. Metals)	15	14	16	21	21	32	37	35	36	47	47	48
Core commodities												
Metal products	6	7	10	9	14	10	17	16	18	20	21	26
Machinery	1	4	7	8	3	15	22	36	41	54	55	60
Chemicals	7	11	11	14	22	21	21	22	16	15	17	20
Total	**105**	**140**	**160**	**175**	**200**	**209**	**241**	**238**	**244**	**252**	**256**	**265**

Finally, we also analyze how the number of core products exported with RCA > 1 relative to the total number of products exported with RCA > 1 changes with the level of income. As discussed earlier, core products embody, in general, more complex capabilities than other products. Therefore, it could be the case that two countries export a similar number of products with RCA > 1, but one of them has RCA > 1 in a larger number of core products. Capabilities in these two countries are of a very different nature. In Fig. 5, we examine how the share of the core commodities exported with RCA > 1 (we call this share_core) changes with the level of income per capita. We estimate a regression of the log of share_core on the log of GDP per capita, its square and its cube. Also included is the dummy variable for the period 1986–2007. Specifically, the relationship estimated is the following:

$$\ln(share\_core_{jt}) = \alpha_0 + \alpha_1 \ln(GDPpc_{jt}) + \alpha_2(\ln(GDPpc))^2 + \alpha_3(\ln(GDPpc))^3 + \delta_t(\text{dummy1986} - 2007) + \varepsilon_{jt} \quad (5)$$

All the terms included in Eq. (5) are statistically significant at the 1% level. Fig. 5, using the estimated relationship from Eq. (5), shows that the share_core in India was above what could be expected for a country at a similar level of income.

3.3. India's comparative advantage in labor, capital, and skilled-intensive products

In this section, we look at the data from a different perspective and analyze India's performance in labor-intensive products, and its progression into the export of sophisticated products. To do so, we look at the number of products exported with RCA > 1 in different factor intensive categories within the manufacturing sector.

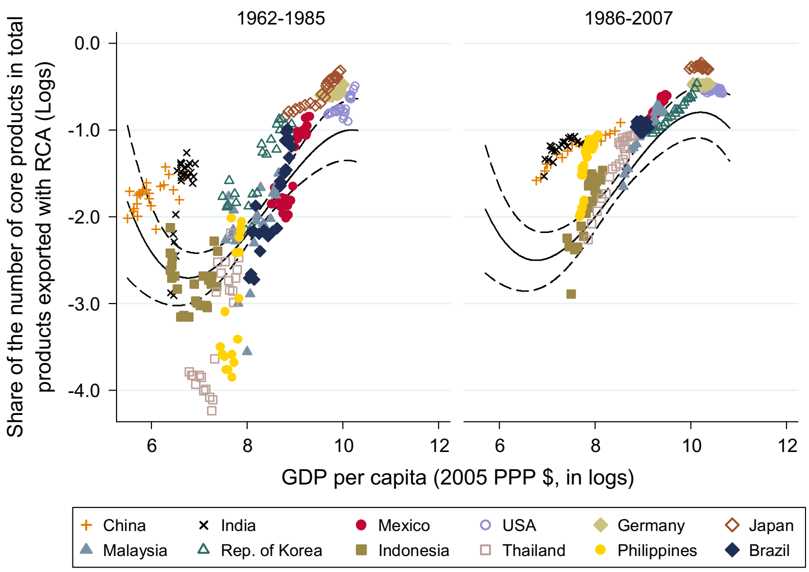

Fig. 5. Share_core and GDP per Capita, 1962–2007. *Source*: UNCOMTRADE, WDI, and authors' estimations. The solid line is the estimated regression corresponding to Eq. (5); the dotted line is the 95% confidence interval. The scatter plot shows the actual share of the number of core products in the total number of products exported with RCA (on *Y*-axis) for different countries.

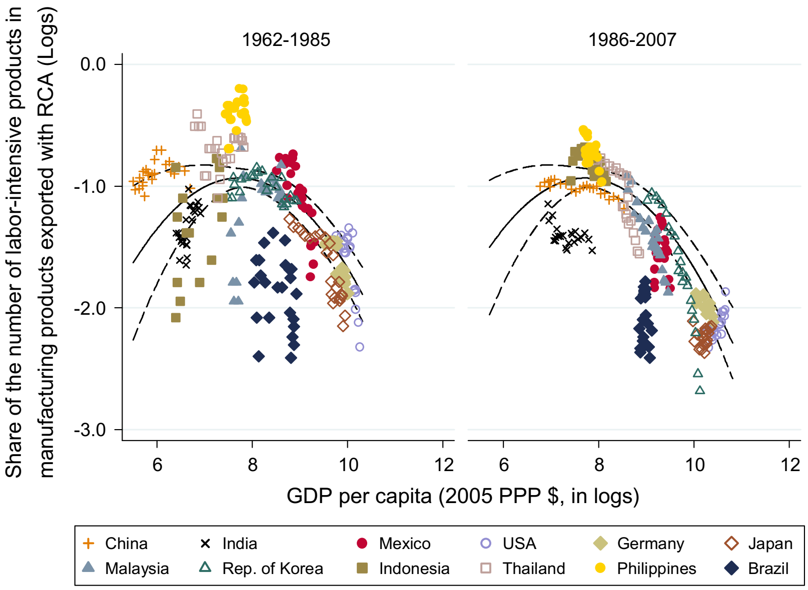

Fig. 6. Share of labor-intensive products in total manufacturing products exported with RCA and GDP per Capita, 1962–2007. *Source*: UNCOMTRADE, WDI, and authors' estimations. The solid line is the estimated regression corresponding to Eq. (6); the dotted line is the 95% confidence interval. The scatter plot shows the actual share of the number of labor-intensive products in the total number of manufacturing products exported with RCA (on the *Y*-axis) for different countries.

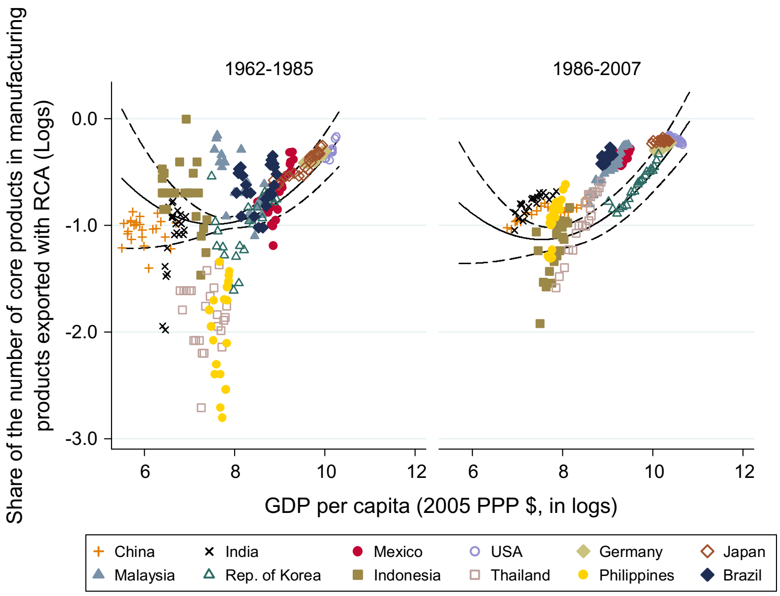

Fig. 7. Share of core products in total manufacturing products exported with RCA and GDP per Capita, 1962–2007, Source: UNCOMTRADE, WDI, and authors' estimations. The solid line is the estimated regression corresponding to Eq. (7); the dotted line is the 95% confidence interval. The scatter plot shows the actual share of the number of core products in the total number of manufacturing products exported with RCA (on the *Y*-axis) for different countries.

We start by looking at the labor-intensive sector. To do so, we examine how the number of products exported with RCA > 1 in the labor-intensive sector (as defined in the Leamer (1984) classification) changes with income per capita. To this purpose, we estimate the following regression:

$$Z_{jt} = \alpha_0 + \alpha_1 \ln(GDPpc_{jt}) + \alpha_2 (\ln(GDPpc))^2 + \varepsilon_{jt} \tag{6}$$

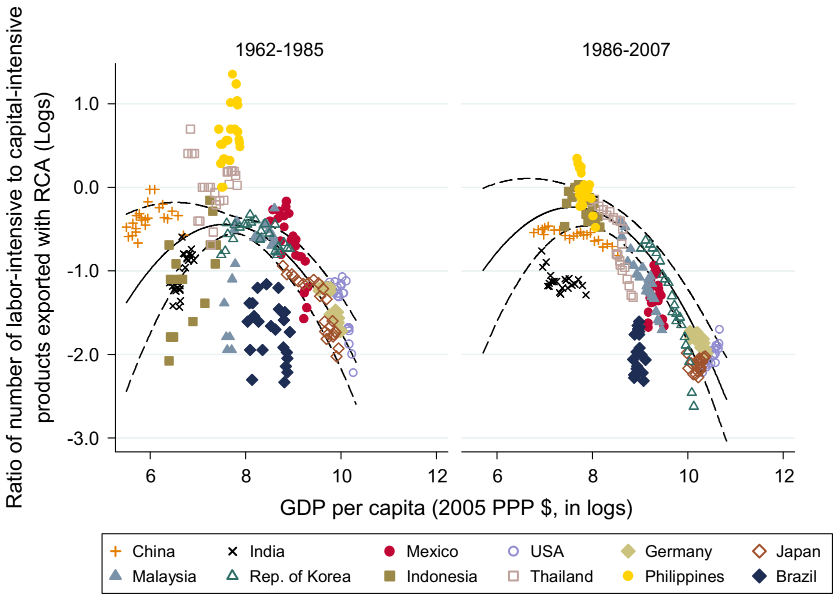

Fig. 8. Ratio of the number of labor-intensive manufacturing products exported with RCA to the number of capital-intensive manufacturing products exported with RCA and GDP per Capita, 1962–2007. *Source*: UNCOMTRADE, WDI, and authors' estimations. The solid line is the estimated regression corresponding to Eq. (8); the dotted line is the 95% confidence interval. The scatter plot shows the actual ratio of the number of labor-intensive to the number of capital-intensive products exported with RCA (on the *Y*-axis) for different countries.

Z is defined as the log of the share of labor-intensive products exported with RCA > 1 in the total number of manufacturing products exported with RCA > 1.[20] All variables are statistically significant at the 1% level. Fig. 6 shows the estimated values and the 95% confidence interval obtained in the estimation of Eq. (6). During both subperiods, the share of labor-intensive products in total manufacturing products exported with RCA > 1 by India was below the fitted line. While for the first period the share of labor-intensive products was mostly within the 95% confidence interval, for the second period the share was below the estimated line and outside the 95% confidence interval, i.e., the share of labor-intensive products in total manufacturing products exported with RCA > 1 was significantly below what could be expected for a country at India's level of development (during 1986–2007). In the case of China, on the other hand, the share lies within the 95% confidence interval.

Fig. 5 showed the share of the number of core products exported with RCA > 1 in the total number of products exported with RCA > 1. In this section we focus only on the manufacturing subgroup. In Fig. 7, we show how the share of the number of core products (note that all core products are manufacturing products) in manufacturing products exported with RCA > 1 changes with income per capita. We estimate the following regression:

$$Z_{jt} = \alpha_0 + \alpha_1 \ln(GDPpc_{jt}) + \alpha_2(\ln(GDPpc))^2 + \delta_t(\text{dummy}1986\text{—}2007) + \varepsilon_{jt} \tag{7}$$

Z is the log of the share of core products exported with RCA > 1 in the total number of manufacturing products exported with RCA > 1. All variables included in the regression are statistically significant at the 1% level.

Fig. 7 shows the relationship estimated in Eq. (7). We find that, for the first period, the share of core products exported with RCA > 1 (by India) in the total number of manufacturing products exported with RCA > 1 was within the 95% confidence interval; but for the second period it was above the fitted line and outside the confidence interval. In other words, the share of the number of core products in the total number of manufacturing products exported with RCA > 1 is above than what would be expected for a country at India's level of development.

Next, we examine how the ratio of the number of labor-intensive products to the number of capital-intensive products exported with RCA > 1 changes with per capita income. Appendix Table 2 lists the Leamer (1984) groups categorized in terms of their relative use of labor and capital.[21] We estimate the following regression:

$$Z_{jt} = \alpha_0 + \alpha_1 \ln(GDPpc_{jt}) + \alpha_2(\ln(GDPpc))^2 + \delta_t(\text{dummy}1986\text{—}2007) + \varepsilon_{jt} \tag{8}$$

[20] The manufacturing sector is defined to include labor-intensive, capital-intensive, machinery, and chemicals as defined in Leamer (1984); see Appendix Table A.1. It is common in the literature to use SITC (Rev. 2) codes 5–8 (except 68) as manufacturing products. However, in using the above definition of the manufacturing sector, we leave out two sectors, namely 63 and 64 (which fall under forest products according to Leamer (1984) classification; see Appendix Table A.1).

[21] Capital-intensive products, which use relatively more capital, are defined to include: (i) capital-intensive; (ii) machinery; and (iii) chemicals, as defined by Leamer (1984). Labor-intensive products (as defined by Leamer, 1984) use relatively more labor. Leamer (1984) categories are provided in Appendix Table A.1.

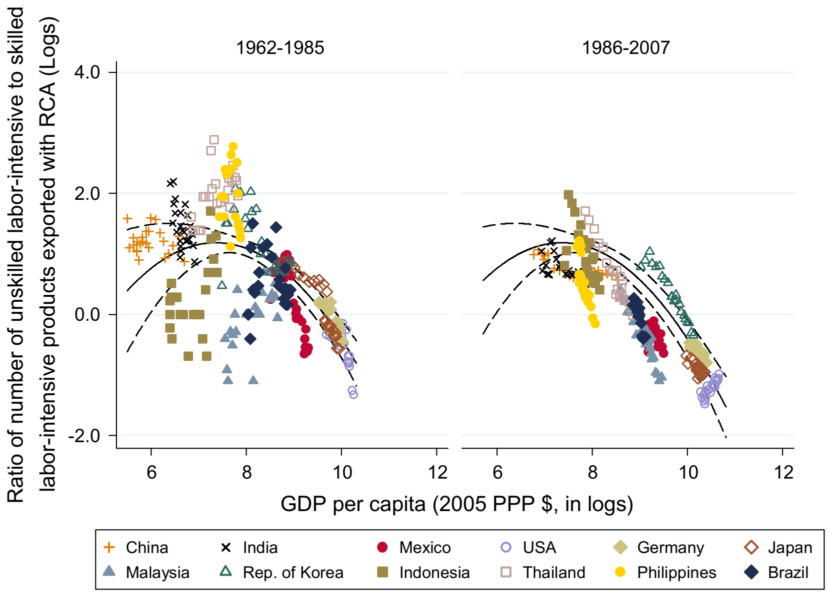

Fig. 9. Ratio of the number of unskilled labor-intensive manufacturing products exported with RCA to the number of skilled labor-intensive manufacturing products exported with RCA and GDP per Capita, 1962–2007. *Source*: UNCOMTRADE, WDI, and authors' estimations. The solid line is the estimated regression corresponding to Eq. (9); the dotted line is the 95% confidence interval. The scatter plot shows the actual ratio of the number of unskilled labor-intensive products to the number of skilled labor-intensive products exported with RCA (on the *Y*-axis) for different countries.

Z is defined as the log of the ratio of number of labor-intensive products exported with RCA > 1 to the number of capital-intensive exported with RCA > 1. The coefficients on log of GDP per capita and its square are statistically significant at the 1% level, whereas the dummy variable for the period 1986–2007 is statistically significant at the 5% level.

Fig. 8 shows the estimated relationship. We find that India was below the fitted line, though within the confidence interval during most of the first period, 1962–1985. During 1986–2007, India was below the fitted line and outside the 95% confidence interval, i.e., the ratio of the number of labor-intensive products to the number of capital-intensive products exported with RCA > 1 was less than what would be expected. This is because India exports a small number of labor-intensive products, or a high number of capital-intensive products, with RCA > 1. Figs. 6 and 7 showed that both are in fact true. In the case of China, though this ratio is below the fitted line for the period 1986–2007, it is higher than India's.

Fig. 9 looks at the ratio of the number of unskilled labor-intensive products to the number of skilled labor-intensive products exported with RCA > 1. We estimate the following regression:

$$Z_{jt} = \alpha_0 + \alpha_1 \ln(GDPpc_{jt}) + \alpha_2(\ln(GDPpc))^2 + \varepsilon_{jt} \quad (9)$$

Z is the log of the ratio of number of unskilled labor-intensive products exported with RCA > 1 to the number of skilled labor-intensive exported with RCA > 1.[22] The coefficients of the log of GDP per capita and its square are significant at the 1% level.

Using the estimated relationship in Eq. (9), shown in Fig. 9, we find that India was largely within the 95% confidence interval during both periods, although in the first one it was mostly above the estimated line; while in the second period it was below the fitted line (i.e., the ratio of the number of unskilled labor-intensive products exported with RCA > 1 to the number of skilled labor-intensive products exported with RCA > 1 was below what could be expected for a country at India's stage of development). This could be either because India exports a high number of skilled labor-intensive products with RCA > 1, or because it is exports a low number of unskilled-labor intensive products with RCA > 1.

Finally, Fig. 10 shows the two opposite ends of factor intensity, i.e., labor-intensive products on the one hand, and machinery and chemicals on the other. Labor-intensive products use relatively more unskilled labor and less capital, whereas machinery and chemicals use relatively more skilled labor and capital. We estimate the following regression:

$$Z_{jt} = \alpha_0 + \alpha_1 \ln(GDPpc_{jt}) + \alpha_2(\ln(GDPpc))^2 + \delta_t(\text{dummy1986–2007}) + \varepsilon_{jt} \quad (10)$$

Z is the log of the ratio of number of labor-intensive products exported with RCA > 1 to the number of machinery and chemical products exported with RCA > 1. The coefficients on log of GDP per capita and its square are statistically significant at the 1% level; and the dummy variable for the period 1986–2007 is statistically significant at the 10% level.

[22] The definition of sectors using relatively more unskilled (skilled) labor and relatively less skilled (unskilled) labor is from Leamer (1984). Labor-intensive and capital-intensive sectors (the latter including metal products) are defined as using relatively more unskilled labor and relatively less skilled labor. Chemicals and machinery sectors are defined as using relatively more skilled labor and relatively less unskilled labor. See Appendix Table A.2.

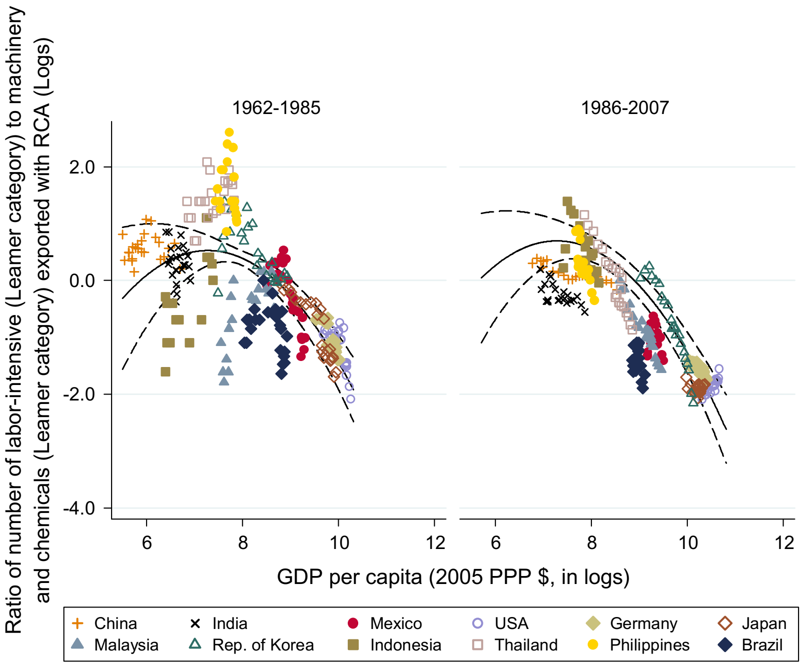

Fig. 10. Ratio of the number of unskilled labor–intensive manufacturing products exported with RCA to the number of skilled labor–and capital-intensive manufacturing products exported with RCA and GDP per Capita, 1962–2007. *Source*: UNCOMTRADE, WDI, and authors' estimations. The solid line is the estimated regression corresponding to Eq. (10); the dotted line is the 95% confidence interval. The scatter plot shows the actual ratio of the number of labor-intensive to the number of machinery and chemical products exported with RCA (on the *Y*-axis) for different countries.

Fig. 10 shows the estimated relationship from Eq. (10) along with the actual ratios. For India and for the first period, we find that the ratio of the number of labor-intensive products to the number of machinery and chemical products exported with RCA > 1 is within the 95% confidence interval, i.e., India's share is what could be expected for a country at India's level of development. For the second period, India is below the fitted line and outside the confidence interval, indicating that the ratio is significantly different from the expected value. And in the second period, India's ratio is below that of China.

4. Discussion

Our findings are consistent with those of Kochhar et al. (2006) who, using cross-country data for manufacturing output for 1981, found that India's manufacturing sector was biased towards large-scale (capital-intensive) or skilled labor-intensive sectors.[23] They also found that the Indian manufacturing sector was more diversified than would be expected given India's level of development. This pattern has persisted even after twenty years of significant reforms. Panagariya (2004) argues that reforms have been unable to provide impetus to India's labor-intensive manufacturing industries, and that the exports of labor-intensive industries have not grown rapidly. This is where India lags behind China.

The Nehru–Mahalanobis blueprint for India's development recognized very early on the critical importance of the heavy machinery sector. The data show clearly that India has made fast inroads in the exports of capital- or skilled labor-intensive industries. As Table 1 shows, of the 157 commodities exported with RCA > 1 in 1980, 38 (a quarter of the total) were "core commodities". This means that by 1980 India had accumulated capabilities to produce and export a significant number of sophisticated products. Between 1980 and 2007, the period during which the industrial licensing regime was dismantled and import barriers were brought down (tariff rates are still among the highest in the world), the number of commodities with RCA increased to 254, a net gain of 97 commodities. Of these 97, 46 were "core commodities". As shown by the fact that other countries at a similar level of development have a much smaller presence in "core commodities", India has been an outlier in terms of diversification and sophistication. This may have been the outcome of the industrial development strategy

[23] To be precise, Kochhar et al. (2006) find a bias towards large-scale sectors. They note that the measure of scale used in their paper could also be a proxy for capital intensity. The definition of skilled labor–intensive and large sectors used in Kochhar et al. (2006) is different from the one used here. Kochhar et al. (2006) measure labor intensity by the share of wages in value-added for the industry in a country (averaged across a broad group of developing countries). Relative size is the ratio of value-added per establishment within the industry over the value-added per establishment within the country, averaged across countries for each industry. Skill is measured by the ratio of remuneration of highly skilled and skilled labor over the total value-added of the industry. Categorization of manufacturing sectors according to factor-intensity as used in this paper is shown in Appendix Table A.2.

that made heavy machinery a focal point. Our argument is not that all the policies implemented pre-1980s were successful, or that the right tools were used to promote the heavy machinery sector.

The stock of capabilities and technologies that were built as a part of heavy machinery-led industrialization provided India with a foothold into the "core commodities" as well as the necessary building blocks to exploit other nearby products once the license–permit raj was eliminated. On the other hand, the labor-intensive sectors continued to be bound by labor laws and small-scale reservation (until the 1990s when the first set of de-reservation was introduced), which did not allow the labor intensive sectors to reap economies of scale by reaching optimal size. They together tilted the composition of the manufacturing sector towards the skill-intensive, capital-intensive sector and away from the unskilled labor-intensive sector.

Similarly, the finding that India was more diversified (as measured by the number of products exported with RCA > 1) may have been the result of a bias towards producing anything that could be produced domestically in an import-substitution-based industrialization strategy. Though this may not have been the best use of the scarce resources at the time, it did help accumulate capabilities in a wide array of products. In other words, India gained RCA in a variety of products, which in turn led to the accumulation of a diverse set of capabilities, making it easier to acquire RCA in other products.

Another related factor that assisted in establishing an industrial sector biased towards the skill-intensive activities was the creation of a scientific and a technical infrastructure, as well as the setting up of institutes of higher education, especially in engineering and management. Institutions of higher education, research, and development, which were established in the post-independence period, provided the know-how and highly skilled low-cost labor for industrial development, especially for the heavy machinery, metals, and the chemical sectors. The ready availability of a solid scientific and technical base, low-cost skilled labor, and experienced professionals provided the human resources to support the setting up as well as the growth of the information technology and communications industry.[24]

Finally, the reason why we talk about comparative advantage in labor intensive products is that for labor–abundant countries like China and India one would expect to see RCA > 1 in such products. While China does show significant gains in labor-intensive products, India does not.

The comparison with China is enlightening because China and India are the world's two most populous countries, and India was ahead of China in terms of per capita income in the late 1970s. Today, China is the world's factory. India, on the other hand, is the world's back office, which requires more skill-intensive labor. Today, China's per capita income is far ahead that of India. While China has managed to absorb surplus labor from agriculture, India has failed to do so. Absorbing vast surplus agricultural labor into the modern sectors continues to be a challenge that can partly be addressed through the expansion of the unskilled labor-intensive manufacturing sectors.

5. Conclusions

In this paper, we have examined the sophistication and diversification of India's export basket since the 1960s. The industrial development strategy adopted after independence favored the heavy machinery and capital-intensive sectors at the expense of the labor-intensive activities. The latter were promoted by reserving some products exclusively to be produced by small units. The data show that: (i) on both accounts, overall sophistication and diversification of the export package, India is a positive outlier after controlling for income per capita; (ii) India has succeeded in acquiring RCA in a significant number of sophisticated products, and now exports a large number of chemical, machinery, and metal products with RCA > 1; and (iii) the number of labor-intensive products exported with RCA > 1 has increased during the last five decades. Overall, India is exporting fewer labor-intensive products and a higher number of skilled labor-intensive products (and also the ones using relatively more capital) as a share of the total number of manufacturing products exported with RCA > 1 than is typical for a country at India's level of per capita income.

Post-reforms, the skilled labor-intensive sectors and the sectors using relatively more capital benefited from the capabilities accumulated that were built as a part of heavy machinery-led industrialization. Taking a path-dependent view of development, this strategy allowed India to accumulate capabilities in key areas. The labor-intensive sector, on the other hand, continued to be bound by rigid labor laws and small-scale industrial policy (until recently), which prevented firms from operating at the optimal size and from achieving economies of scale required in a world of wafer-thin profit margins. The significant number of reforms introduced since the 1980s have not led to the expansion of the labor-intensive sectors. Herein lies India's failure and the difference with China.

Acknowledgments

We are grateful to Rana Hasan for his invaluable comments and suggestions. We also thank two anonymous referees for helpful comments and suggestions that helped us clarify some of the arguments. The usual disclaimer applies. This paper represents the views of the authors, and not those of the Asian Development Bank, those of its Executive Directors, or of the member countries that they represent.

[24] The information technology (IT) sector has become a leading sector in India during the last decade. The rise of the IT sector is sometimes attributed to "benign neglect", in the sense that it was outside the ambit of the licensing system, and was not regulated and controlled as the manufacturing sector. Nevertheless, Balakrishnan (2006) and Singh (2010) note that the IT sector was a beneficiary of a "newer" industrial policy framework that promoted and encouraged new activities, rather than regulated and controlled them.

Appendix A. Data appendix

A.1. Trade data

We use the SITC-Rev.2 (4-digit level) trade data for the years 1962–2007. Data for 1965–2007 is taken from Feenstra et al. (2005). This data set is extended to 2007 using the UNCOMTRADE Database.

The definitions of core and periphery commodities come from the newly developed literature on the *product space* (Hidalgo et al. (2007)). Core commodities are chemicals (SITC Rev. 2 categories 51–59), machinery (SITC Rev2 categories 71–79, 87, 88, 95), and metal products (SITC Rev. 2 categories 67, 69). There are a total of 320 core products, 41% of the total. The periphery consists of petroleum, raw materials, tropical agriculture, animal products, cereals, labor-intensive goods, and capital-intensive goods (excluding metal products). These categories are based on the Leamer (1984) classification. Following Hidalgo et al. (2007), the capital-intensive category as defined by Leamer (1984) is split into two: capital-intensive goods (excluding metal products) and metal products. Leamer (1984: 73) notes that the labor-intensive category uses unskilled labor; capital-intensive uses capital and unskilled labor; machinery uses skilled labor and moderate amounts of capital; and chemical uses skilled labor and very large amounts of capital. Note that since the capital-intensive category, as defined by Leamer (1984), is divided into two groups in this paper, we assume both capital-intensive (excluding metal products) and metal products use capital and unskilled labor. In general, the core products tend to be more skilled labor-intensive, as well as use relatively more capital than other manufacturing products. Also see Appendix Tables A.1 and A.2.

Appendix Table A.1
Leamer's classification and SITC Rev. 2 (2-digit). *Source*: Leamer (1984) and Hidalgo et al. (2007).

Leamer's classification	SITC	Leamer's classification	SITC
1. Petroleum		7. Labor-intensive	
Petroleum and petroleum products	33	Non-metallic mineral	66
		Furniture	82
2. Raw materials		Travel goods, handbags	83
Crude fertilizer and crude minerals	27	Articles of apparel	84
Metalliferous ores	28	Footwear	85
Coal	32	Miscellaneous manufacture	89
Gas	34	Postal packages, not classified	91
Electric current	35	Special transactions, not classified	93
Non-ferrous metals	68	Coin (other than gold coin)	96
Gold, non-monetary	97		
3. Forest products		8. Capital-intensive	
Cork and wood	24	Leather	61
Pulp and waste paper	25	Rubber	62
Cork and wood	63	Textile yarn, fabrics	65
Paper	64	Sanitary fixtures and fittings, nes	81
		Iron and steel	*67*
		Manufactures of metals, nes	*69*
4. Tropical Agriculture			
Vegetables and fruit	05	9. Machinery	
Sugar	06	*Power generating*	*71*
Coffee	07	*Specialized for particular industries*	*72*
Beverages	11	*Metalworking*	*73*
Crude rubber	23	*General industrial*	*74*
		Office and data processing	*75*
5. Animal products		*Telecommunications*	*76*
Live animals	00	*Electrical*	*77*
Meat	01	*Road vehicles*	*78*
Dairy products	02	*Other transport equipment*	*79*
Fish	03	*Professional and scientific instruments*	*87*
Hides, skins	21	*Photographic equipment*	*88*
Crude animal and vegetable materials	29	*Armoured vehicles, firearms, and ammunition*	*95*
Animal and vegetable oils and fats	43		
Animals, live (nes)	94	10. Chemicals	
6. Cereals		*Organic*	*51*
Cereals	04	*Inorganic*	*52*
Feeds	08	*Dyeing and tanning*	*53*
Miscellaneous edible products	09	*Medicinal and pharmaceutical*	*54*
Tobacco	12	*Oils and perfume*	*55*
Oil seeds	22	*Fertilizers*	*56*
Textile fibers	26	*Explosives*	*57*
Animal oils and fats	41	*Artificial resins and plastic*	*58*
Fixed vegetable oils and fats	42	*Chemical materials, nes*	*59*

Note: Italicized subsectors are "core".

Appendix Table A.2
Categorization of manufacturing sector products by factor intensity.

Sectors using relatively more labor and relatively less of capital	*Sectors using relatively more unskilled labor and relatively less of skilled labor*
Labor-intensive	Labor-intensive Capital-intensive (excluding metal products) Metal products[#]
Sectors using relatively more capital and relatively less of labor	*Sectors using relatively more skilled-labor and relatively less of unskilled-labor*
Capital-intensive (excluding metal products) Metal products[#] Machinery Chemicals	Machinery Chemicals

Note: Manufacturing sectors are based on the Leamer (1984) terminology shown in Appendix Table A.1.
[#] SITC (Rev. 2) codes 67 and 69 are categorized as capital-intensive sectors by Leamer (1984). However, following Hidalgo et al. (2007), SITC (Rev. 2) are grouped together as metal products and considered as core products for the purposes of this paper. See Appendix Table A.1.

A.2. GDP data

Unless otherwise noted, at all places in the paper, GDP per capita (measured in 2005 PPP $) is used and is taken from the World Development Indicators. The series was extended backwards using growth rates of GDP per capita from Penn World Tables.

A.3. EXPY and PRODY

Following Hausmann et al. (2007), EXPY is calculated as:

$$EXPY_c = \sum_i \left(\frac{xval_{ci}}{\sum_i xval_{ci}} \times PRODY_i \right)$$

EXPY is measured in 2005 PPP$. PRODY provides a measure of the income content of a product and is therefore not an engineering notion. Hausmann et al. (2007) calculate PRODY as a weighted average of the GDP per capita of the countries that export the product in question. This is calculated individually for each product. Algebraically:

$$PRODY_i = \sum_c \left[\frac{xval_{ci}/\sum_i xval_{ci}}{\sum_c (xval_{ci}/\sum_i xval_{ci})} \right] \times GDPpc_c$$

where $xval_{ci}$ is the value of country c's export of commodity i and $GDPpc_c$ is country c's GDP per capita (measured in 2005 PPP$). PRODY is measured in 2005 PPP$. In this paper, PRODY is calculated for 779 products (SITC-Rev.2 4-digit level). PRODY used for calculating EXPY is the average of the PRODY of each product in the years 2003–2005. GDP per capita. To calculate EXPY for the years 1962–2007, average PRODY for 2003–2005 is used. Variation in EXPY overtime comes from changing weight of the products in the export basket of the country.

A.4. Diversification

We use the measure proposed by Balassa (1965), Algebraically:

$$RCA_{ci} = \frac{xval_{ci}/\sum_i xval_{ci}}{\sum_c xval_{ci}/\sum_i \sum_c xval_{ci}}$$

Country c is said to have revealed comparative advantage in a commodity i if the above defined index, RCA_{ci}, is greater than 1.

A.5. Countries included in the estimation sample

The estimation sample is limited to countries with at least 36 years of data and with a population of at least two million; oil exporters (Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Oman, Qatar, Saudi Arabia, United Arab Emirates, and Venezuela) are excluded. Liberia is also excluded from the sample as its GDP falls over time. Countries included in the estimation sample are listed below. A total of 96 countries are in the estimation sample.

A.6. List of countries

Albania	Dominican Republic	Lao PDR	Rep. of Korea
Argentina	Egypt	Lebanon	Romania
Australia	El Salvador	Madagascar	Rwanda
Austria	Ethiopia	Malawi	Senegal
Bangladesh	Finland	Malaysia	Sierra Leone
Belgium	France	Mali	Singapore
Benin	Germany	Mexico	South Africa
Bolivia	Ghana	Mongolia	Spain
Brazil	Greece	Morocco	Sri Lanka
Bulgaria	Guatemala	Mozambique	Sudan
Burkina Faso	Guinea	Nepal	Sweden
Burundi	Haiti	Netherlands	Switzerland
Cambodia	Honduras	New Zealand	Syria
Cameroon	Hong Kong, China	Nicaragua	Tanzania
Canada	Hungary	Niger	Thailand
Central African Rep.	India	Norway	Togo
Chad	Indonesia	Pakistan	Tunisia
Chile	Ireland	Panama	Turkey
China	Israel	Papua New Guinea	Uganda
Colombia	Italy	Paraguay	United Kingdom
Congo	Jamaica	Peru	Uruguay
Costa Rica	Japan	Philippines	USA
Côte d'Ivoire	Jordan	Poland	Viet Nam
Denmark	Kenya	Portugal	Zambia

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