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Michele Alessandrini, Bassam Fattouh, Benno Ferrarini,
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No. 177 | November 2009



ADB Economics Working Paper Series No. 177

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Asian Development Bank

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6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
www.adb.org/economics

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November 2009
ISSN 1655-5252
Publication Stock No. WPS09_____

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Contents

Abstract	v
I. Introduction	1
II. Trade Liberalization Episodes in India	2
III. Measuring India's Trade Specialization	6
IV. Dynamic Panel Estimation of the Effects of Tariff Liberalization	13
V. Conclusions	17
Data Appendix	18
References	19

Abstract

Since the early 1990s, India has embarked on economic reforms that have progressively opened up the country to international trade. This paper analyzes the effects of reform on India's trading structure from 1990 to 2006. It computes comparative advantage indicators on the basis of disaggregated trade flow data, and assesses the effects of trade liberalization on the evolution of India's pattern of trade specialization. From dynamic panel regression analysis, evidence is found that those industries where import tariffs have been reduced the most have experienced the highest increase in specialization. Moreover, the analysis shows that trade liberalization has helped India improve its comparative advantage in industries with medium- to high-technology content, as well as in some of the industries enjoying the most robust growth in global demand.

I. Introduction

Until the early 1990s, India was a relatively closed economy. Average import-weighted tariffs exceeded 80%, more than 90% of tradable goods were protected by quantitative restrictions on imports, and foreign investment was subject to strict limitations (Chadha et al. 2003). In 1991, the country embarked on a series of major trade reforms, progressively cutting tariff- and non-tariff barriers, phasing out quantitative restrictions, and easing limitations on the entry of foreign investment. Even though India today can still be considered a heavily protected economy on many accounts, progressive liberalization has produced remarkable results. The country's openness to international trade has more than trebled since the late 1980s, and its economy has been expanding at an astounding pace, second only to the People's Republic of China (PRC) (World Bank 2008).

India's economic progress is broadly acknowledged in the literature, and much attention has been devoted to analyzing those sectors that have contributed most strongly to its success, most notably India's services industry. However, the extant research has focused less on the systematic study of the changes to India's industrial structure in the wake of progressive trade liberalization.¹ The notable exception to this has been an array of computable general equilibrium approaches, which however are mostly limited to assessing the impact on India from complying with specific World Trade Organization (WTO) agreements (e.g., Mattoo and Stern 2003), or from entering new bilateral or plurilateral agreements with specific partner countries or regions (e.g., see Francois, Norberg, and Pelkmans-Balaoing 2008 on the effects of the EU-India Free Trade Agreement).

The aim of this paper is to investigate how the trade structure of India's industry has responded to the liberalization that took off in the early 1990s. This paper assesses the evolution of the country's revealed compared advantage (RCA), or trade specialization, computed on the basis of detailed merchandise trade flow data. India's trade specialization pattern is further classified by the level of productivity and technology embodied in the product categories traded. This paper then estimates the effects of progressive tariff cuts—a proxy for broader trade liberalization—on the comparative advantage structure of India's merchandise industry, and trading internationally. The dynamic implications of trade reform are shown to be broadly consistent with the central postulate of recent international trade theory emphasizing the asymmetrical impact of trade liberalization across industries and firms, whereby the more dynamic sectors

¹ One exception being Alessandrini, Fattouh, and Scaramozzino (2007), a precursor to the present study.

are able to respond to increased competitive pressures with improved productivity and profitability at the expense of those sectors that are not. For India, the benefits of trade liberalization have been to foster its competitive position in some of the sectors with medium and higher technological content, as well as in sectors that have been enjoying a rapid expansion of world demand.

The remainder of the paper is organized as follows. Section II traces the key policy reforms and liberalization episodes India has undergone since the early 1990s. Section III measures the revealed comparative advantage of India's industry, categorizes its industries by the level of technological content and productivity they embody, and analyzes the evolution of India's trade specialization. Section IV implements a dynamic estimation technique across a panel of trade by industries and time, to assess the effect of liberalization on the structure of India's international trade. Section V concludes.

II. Trade Liberalization Episodes in India

Since the early 1980s, the economy of India has been expanding at an average rate of about 6% per year in real terms (World Bank 2008). This makes it the economy with the most robust and sustained growth record, second only to the PRC.² India's early performance was shaped by two distinct policy approaches that the Government of India had been pursuing since the 1980s: the "pro-business" reforms promoted by Prime Minister Indira Gandhi and later reinforced by the office of her son Rajiv, during the second half of the 1980s, and the "pro-market" strategy in the 1990s, first enacted by the Minister of Finance Manmohan Singh under the Narasimha Rao government (Rodrik and Subramanian 2004; Kohli 2006a, 2006b). The two strategies attributed opposite roles to India's foreign trade. The business-friendly approach aimed at reinforcing the domestic industry through an increase in productivity under state protection from foreign import competition and the market-friendly phase made international trade a key priority, progressively opening up the economy and exposing firms in India to international competition.

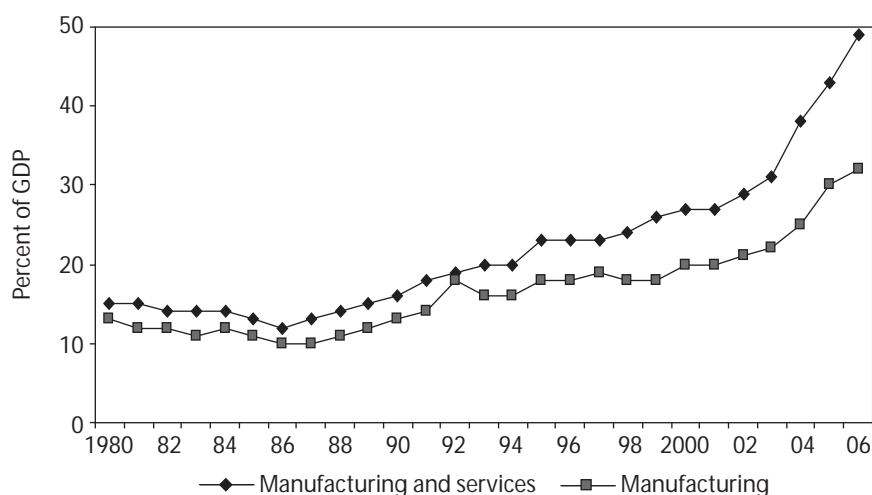
The market-oriented phase, which is the focus of this paper, was embodied by the New Industrial Policy endorsed in July 1991 on the heels of the political and financial crisis the country had endured during the preceding 2 years. The new trade policy was spelled out in the 5-year Export Import (Exim) Policy, which took effect in April 1992. The main objective of the government's new economic strategy was to deregulate the domestic industry and to liberalize external trade (Panagariya 2004). To deregulate industry, the industrial licensing system was largely abolished; the public sector monopoly was reduced to a number of strategic activities; and limitations on foreign direct investment were lifted and special economic zones created, especially for the information technology industry. To liberalize trade, the industrial policy package involved, inter alia, the

² The PRC outperforms any other country, with almost 10% real annual growth during 1980–2006 (World Bank 2008).

dismantling of the import licensing systems on virtually all intermediate inputs and capital goods³; the lowering of tariffs by capping peak tariff rates and by rationalizing the tariff structure by reducing the number of bands; the devaluation of India's national currency—the rupee—against the dollar, and the introduction of a dual exchange rate; the gradual phasing out of heavy government intervention in the key sectors of insurance, banking, telecommunications, and infrastructure; and the piecemeal opening up of the services sector to private domestic and, increasingly, foreign investment.

From 1997 to 2002, a new Exim policy was enacted to consolidate the process of trade reforms and trade liberalization made possible during the preceding 5-year Exim policy. Overall, the reforms of the 1990s have been highly successful in opening up India's economy progressively over the years. Although India's economic openness might still be considered as moderate compared to that of many other countries in the developing world, its transformation appears quite dramatic when assessed against the country's own historic standards (Kohli 2006b). Figure 1 traces India's economic openness over time, gauged by the standard measure of total trade to gross domestic product (GDP). By this metric, the country's openness worsened up to 1986, and steadily improved in the years thereafter. The ratio doubled from a level about 15% during most of the 1980s, to 27% in 2000, and up to 47% in 2006 (World Bank 2008). As is widely acknowledged, the formidable performance of India's services sector accounts for the bulk of the increase in total exports, particularly since the second half of the 1990s. As ratio of GDP, services trade reached 15% in 2006, up from just 3% in 1990. Furthermore, India's total share in world trade more than doubled in 1990–2006, from 1.2% to 2.6% (World Bank 2008). Similarly, India's inward stock of foreign direct investment as ratio rose from 0.5% of GDP in 1990 to above 9.0% in 2006 (UNCTAD 2008).

Figure 1: Degree of Openness, 1980–2006



GDP = gross domestic product.

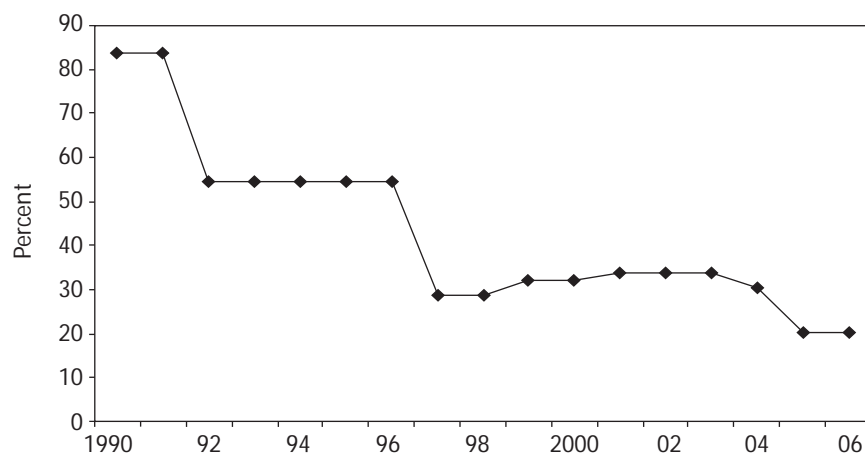
Note: Openness is measured as the ratio of total trade to GDP.

Source: World Bank 2008.

³ Consumer goods, however, remained most heavily protected through licensing until a decade later when they had to be liberalized in line with India's WTO obligations (Williamson and Zaghera 2002).

The observed fall in import tariffs closely reflects the country's pursuit of a more open trade policy. Figure 2 traces the import-weighted average of applied tariffs across India's manufacturing imports from 1990 to 2006.⁴ The data suggest that the trade liberalization episode that took off in 1991 implied a substantial cut in tariffs on manufacturing imports, from about 83% in 1990 to less than 55% by 1992. Tariffs experienced a further radical cut from 1996 to 1997, dropping to about 29% on average around the time when the second Exim policy was enacted. After a temporary reversal—mainly on account of low-technological products, as discussed in Section III—India's average tariff level reached 21% in 2006.

Figure 2: Average Tariff Level, Manufacturing Products, 1990–2006



Note: Based on SITC Revision 3, four-digit level.

Source: UN TRAINS database.

Hidden behind the average figure shown in Figure 1, however, is the huge dispersion of tariffs around the mean, with prohibitive peak tariffs.⁵ Put differently, India's trade reform was neither comprehensive nor unbiased. In accordance with its WTO commitments, India's liberalization was uneven across product categories, geared mainly toward the liberalization of manufactured goods and far less on agricultural products. Indeed, Table 1 shows that in 1989/1990,⁶ food items and manufactured goods were the most heavily protected product categories, with average tariffs at level 84% and 89%, respectively. Subsequently, import tariffs on manufactures decreased sharply, to 31% by 1997/1998 and further down to 17% by 2005/2006. In contrast, tariffs on food items reversed up again, to 43% in 2005/2006, after having dropped to 30% in 1997/1998. Finally, among the group of manufactured goods it was mainly production inputs, crucial to the process of industrialization, which experienced the deepest cuts. Import tariffs on "Chemicals products", for example, were slashed from 99% to 16% from 1989/1990 to 2005/2006.

⁴ The average is computed on the basis of 4-digit clusters of trade data reported in the UN TRAINS database.

⁵ For example, in 1990 the tariff levied on imports of "Polyvinyl chloride wasted (5793)" was as high as 534%.

⁶ Table 1 lists tariff levels as 2-year averages to reduce the bearing of year-to-year fluctuations on the current discussion. Henceforth, all data in this paper will be expressed as 2-year averages.

Table 1: Average Applied Level of Tariffs by Product Category

Tariffs computed as 2-year averages (percent)	1989/1990	1997/1998	2005/2006
All food items (0, 1, 22, 4)	84	30	43
Agricultural raw materials (2 excl. 22, 27, 28)	56	17	16
Fuels (3)	45	15	13
Ores and metals (27, 28, 68)	62	20	12
Manufactured goods (5, 6, 7, 8 excl. 68)	89	31	17
<i>Chemicals products (5)</i>	99	30	16
<i>Manufactured goods classified chiefly (6 excl. 68)</i>	93	33	18
<i>Machinery and transport equipment (7)</i>	76	25	15
<i>Miscellaneous manufactured goods (8)</i>	90	34	19
All sectors	83	29	21
Standard deviation	51.85	14.27	17.83
Maximum	534	260	182

Note: Sectors are classified according to the customary breakdown, see UNCTAD (2007).

Source: UN TRAINS database.

The period of overall decrease in tariffs during the decade of “pro-market” policy is associated with a progressive transformation in India’s trade structure. Table 2 lists major product categories’ share of total exports and imports.⁷ Total imports of manufactures are shown to have increased from 77.6% to 81.2% over the entire period of observation, whereby most of the increase is on account of “machinery and transport equipment”, which spiked from 26% to almost 40%. Except for “miscellaneous manufactured goods”, the weight of all the other manufacturing imports registers a decline. With respect to exports,⁸ India appears to have gradually shifted from exporting agricultural products (from 16.7% to 10.3%) toward a higher share of manufactured goods (from 73.5% to 77.8%) over the entire period of observation. Among manufactures, “chemicals products” and “machinery and transport equipment” show a rapid expansion, from about 8% to 13%.

⁷ To allow for a better focus on the essential picture, import shares are computed after factoring out “Fuels”, which represented about one-third of India’s total imports by 2005/2006, as a mere reflection of the rapid expansion in the country’s hydrocarbon demand driven by its sustained economic expansion. “Gold non-monetary”, the import share of which jumped from zero to about 8% in 2005/2006, is dropped too, again in order not to blur the picture with an item that is essentially irrelevant in this context.

⁸ Contrary to the case of imports, “Fuels” and “Gold, non-monetary” represent only a tiny share of total exports.

Table 2: Structure of Trade (percent)

Exports	1989/1990	1997/1998	2005/2006
All food items (0, 1, 22, 4)	16,7	18,0	10,3
Agricultural raw materials (2 excl. 22, 27, 28)	3,3	1,9	2,1
Fuels (3)	0,1	0,1	0,5
Ores and metals (27, 28, 68)	6,5	2,9	9,3
Manufactured goods (5, 6, 7, 8 excl. 68)	73,5	77,0	77,8
Chemicals products (5)	7,7	9,9	13,6
Manufactured goods classified chiefly (6 excl. 68)	37,8	37,8	32,2
Machinery and transport equipment (7)	7,8	7,8	13,0
Miscellaneous manufactured goods (8)	20,2	21,5	19,0
Imports, except Fuels (3) and Gold (9)	1989/1990	1997/1998	2005/2006
All food items (0, 1, 22, 4)	7.0	12.4	7.1
Agricultural raw materials (2 excl. 22, 27, 28)	5.6	4.9	3.1
Ores and metals (27, 28, 68)	12.1	9.1	10.0
Manufactured goods (5, 6, 7, 8 excl. 68)	77.6	75.6	81.2
Chemicals products (5)	19.2	20.0	16.0
Manufactured goods classified chiefly (6 excl. 68)	27.5	23.4	19.0
Machinery and transport equipment (7)	26.0	26.4	39.8
Miscellaneous manufactured goods (8)	4.8	5.7	6.4

Note: Sectors are classified according to the customary breakdown, see UNCTAD (2007).

Source: UN TRAINS database.

III. Measuring India's Trade Specialization

This paper measures and analyzes India's changing pattern of trade specialization applying an approach originally adopted in Lafay (1992). The Lafay Index defines a country's trade specialization with regard to a specific good as the difference between the trade balance of that good and the country's overall trade balance, weighted by the good's share of total trade. Both partial and global trade balances are normalized to allow for a comparison over time. More specifically, in the version proposed by Bugamelli (2001), Lafay's revealed comparative advantage index (LFI henceforth) is expressed as:

$$LFI_j = 100 \left(\frac{x_j - m_j}{x_j + m_j} - \frac{\sum_{j=1}^N (x_j - m_j)}{\sum_{j=1}^N (x_j + m_j)} \right) \frac{x_j + m_j}{\sum_{j=1}^N (x_j + m_j)}, \quad (1)$$

where, for any given period t , x_j and m_j denotes a country's exports and imports of good j with the rest of the world, and N is the total number of goods traded. By construction, for each period t , LFI sums up to zero across goods. For each good j the index takes values between plus and minus 50, which, respectively, represent the boundaries in the case of full trade specialization and full de-specialization.

The index for the case of India is calculated on the basis of the Standard International Trade Classification (SITC Revision 3) annual merchandise trade flow data from the United Nations Comtrade database, with data covering 1990–2006. Trade flows are disaggregated to the fourth digit of SITC, which for the case of India includes up to 945 different product categories, depending on the specific year of observation. Such detailed level of analysis is generally considered suitable to account for specialization patterns not only between, but also within, industries and products. To reduce the impact of outliers and year-to-year variations in exchange rates and prices, the index is computed with trade flows taken at the 2-year average.

Products traded are categorized according to their level of technological content and to the average productivity level of exporting nations. The technological content classification is drawn from the Organisation for Economic Co-operation and Development (OECD) STAN database at the three-digits level of the International Standard Industry Classification (ISIC). Using a suitable concordance table⁹, the OECD technology classification is converted to SITC, and mapped onto the four-digit level to allow for analysis at the more disaggregated level of intra-industry activity.

Productivity is proxied by the average per capita GDP across all the world exporting countries reporting to the United Nations, and computed according to an index proposed by Hausmann, Hwang, and Rodrik (HHR) (2005). More specifically, the HHR index associates each export item with the average GDP per capita of all the countries exporting that specific good, weighed by its relative importance in terms of countries' export baskets.¹⁰

$$HHR_j = \sum_c \frac{\left(\frac{x_{j,c}}{\sum_j x_{j,c}} \right)}{\sum_c \left(\frac{x_{j,c}}{\sum_j x_{j,c}} \right)} GDPpc_c, \quad (2)$$

where j denotes the traded goods, SITC Rev.3 at 4 digits; c are all the countries engaging in world trade; x is the export value of good j for country c ; $GDPpc$ is the real per capita GDP of country c , measured at market exchange rates or assuming purchasing power parity; and t denotes time periods or years. From the HHR, four productivity categories along the quartiles of its distribution were derived, which are labeled from one to four, according to increasing levels of average GDP per capita. To compute the HHR index, trade flow data ($x_{j,c}$) are drawn from the COMTRADE database, while GDP per capita is extracted from the Penn World Tables. The data available allow this study to include 142 countries in the computation of HHR indexes for all the goods globally traded during 2000–2002.

⁹ The ISIC-SITC concordance table was drawn from the World Integrated Trade Solution (WITS).

¹⁰ It will be noted that the weights are defined as the traditional (Balassa) measure of revealed comparative advantage, i.e., the ratio of a good's share in an exporter's export basket and its share in relation to world exports.

The *LFI* is computed to compare India's specialization pattern in the 2-year periods before the 1989/1990, during the 1997/1998, and after the 2005/2006 major trade reforms took place.¹¹ For each focus period, Tables 3a–3c rank the *LFI* scores of the top and bottom 15 product categories, alongside their technological content and productivity ratings. A number of conclusions can be drawn from a comparison of India's specialization pattern across the three episodes considered. First, India's revealed comparative advantage is predominantly in low-technology manufactures and commodities, which make up virtually all the top ranking items across the three periods of observation. By contrast, the country's trade pattern reveals a clear disadvantage in its trade in high-technology items (mostly industrial inputs), which dominate the bottom ranks of the *LFI* list, taking the highest negative values.

Table 3a: Top 15 and Bottom 15 Products Groups based on the Lafay Index, 1989/1990

Product	Lafay	Technology	Productivity
0741-Tea	1.74	*	*
2815-Iron ore,conc,not agglom	1.63	*	*
6672-Diamonds unset	1.53	*	*
8427-Womens/girls blouse woven	1.40	*	*
8415-Mens/boys shirts, woven	1.13	*	*
0361-Crustaceans, frozen	1.11	*	*
0813-Oil cake by-products	0.97	*	*
6522-Woven unb cotton fab nes	0.91	*	*
8519-Footwear parts/leggings	0.87	*	*
8481-Leather clothing/access	0.82	*	*
5429-Medicaments nes	0.76	****	****
2631-Raw cotton excl linters	0.75	*	*
6513-Cotton yarn nes	0.73	*	*
6595-Carpets, woven	0.69	*	*
6592-Carpets etc. knotted	0.64	*	*
Average Top	1.05		
6411-Newsprint rolls/sheets	-0.46	*	****
7649-Telecomms parts/access.	-0.48	****	***
2741-Sulphur exc puri ed	-0.52	*	**
2723-Natural phosphates	-0.55	***	*
6791-Iron/steel tube seamless	-0.60	**	**
6821-Copper re ned/unre ned	-0.62	**	*
0542-Dried legumes	-0.66	*	*
5711-Polyethylene	-0.68	**	***
2475-Hardwood,rough,untreated	-0.70	*	*
5623-Chem potassic fertilizer	-0.74	***	**
5223-Inorg acids/oxy compnds	-0.94	***	*
7924-Aircrft nes over 15000kg	-1.01	****	****
3212-Other coal	-1.13	*	**
2823-Ferrous waste/scrap nes	-1.35	*	*
5629-Chemical fertilizers nes	-1.39	***	*
Average Bottom	-0.79		

Source: Authors' calculations based on UN COMTRADE, OECD, and Penn World Tables.

¹¹ As discussed in Section III, the major trade reforms can be identified in the two Exim policies India enacted during 1992–1997 and 1997–2002.

Table 3b: Top 15 and Bottom 15 Products Groups based on the Lafay Index, 1997/1998

Product	LFI	Technology	Productivity
6513-Cotton yarn nes	1.95	*	*
0423-Rice,milled	1.84	*	*
6672-Diamonds unset	1.58	*	*
0361-Crustaceans, frozen	1.19	*	*
8973-Precious metal jewellery	1.15	*	**
8415-Mens/boys shirts, woven	1.14	*	*
8427-Womens/girls blouse woven	1.07	*	*
0813-Oil cake by-products	1.06	*	*
6585-Curtains etc nes	0.81	*	*
0741-Tea	0.76	*	*
5429-Medicaments n.e.s.	0.71	****	***
8424-Womens/girl dresses wven	0.68	*	*
8481-Leather clothing/access	0.64	*	*
6522-Woven unb cotton fab nes	0.62	*	*
2815-Iron ore,conc,not agglom	0.58	*	*
Average Top	1.05		
2882-Non-fer metal waste nes	-0.37	*	*
7284-Special indust machy nes	-0.37	***	****
5623-Chem potassic fertilizer	-0.41	***	**
6411-Newsprint rolls/sheets	-0.42	*	****
0412-Wheat nes/meslin	-0.42	*	**
2823-Ferrous waste/scrap nes	-0.44	*	*
5112-Cyclic hydrocarbons	-0.48	***	***
2475-Hardwood,rough,untreated	-0.56	*	*
5629-Chemical fertilizers nes	-0.58	***	*
3352-Mineral tar/distil prods	-0.63	**	**
6811-Semi-manuf silver/clad	-0.82	**	*
5223-Inorg acids/oxy compnds	-1.27	***	*
4222-Palm oil	-1.34	*	*
3212-Other coal	-1.39	*	**
9710-Gold non-monetary ex ore	-5.69	**	*
Average Bottom	-1.01		

Source: Authors' calculations are based on UN COMTRADE, OECD, and Penn World Tables.

Table 3c: Top 15 and Bottom 15 Products Groups based on the Lafay Index, 2005/2006

Product	LFI	Technology	Productivity
6672-Diamonds unset	2.12	*	*
8973-Precious metal jewellery	2.06	*	**
2815-Iron ore,conc,not agglom	1.89	*	*
5429-Medicaments n.e.s.	0.84	****	***
6513-Cotton yarn nes	0.79	*	*
0423-Rice,milled	0.76	*	*
5169-Oganic chemicals n.e.s.	0.70	***	***
8454-T-shirts/singlets knit/c	0.68	*	**
6585-Curtains etc nes	0.65	*	*
8427-Womens/girls blouse woven	0.64	*	*
6741-Zinc coated/plated steel	0.61	**	**
6821-Copper re ned/unre ned	0.60	**	*
0813-Oil cake by-products	0.58	*	*
7812-Pass motor veh exc buses	0.47	***	***
0361-Crustaceans, frozen	0.46	*	*
Average Top	0.92		
2882-Non-fer metal waste nes	-0.36	*	*
2475-Hardwood,rough,untreated	-0.38	*	*
2823-Ferrous waste/scrap nes	-0.41	*	*
3425-Lique ed butane	-0.44	**	**
7649-Telecomms parts/access.	-0.45	****	***
3431-Natural gas,liqui ed	-0.47	**	****
5223-Inorg acids/oxy compnds	-0.47	***	*
4222-Palm oil	-0.50	*	*
7599-O ce equip parts nes	-0.50	****	***
7641-Telephone equipment	-0.53	****	****
7924-Aircrft nes over 15000kg	-0.79	****	****
2831-Copper ores/concentrates	-1.42	**	*
3212-Other coal	-1.51	*	**
7643-Radio/tv transmit equip.	-1.67	****	****
9710-Gold non-monetary ex ore	-5.58	**	*
Average Bottom	-1.03		

Source: Authors' calculations are based on UN COMTRADE, OECD, and Penn World Tables.

Second, a somewhat higher degree of persistence over time can be observed among the ranks of products India has a comparative advantage in, compared to those listed in the bottom. Moreover, changes in the rankings appear to have mainly occurred from 1997/1998 to 2005/2006, indicating that the effects of tariff cuts gained momentum during the second Exim policy period.

Third, the level of productivity and technological content embodied in the top and bottom items of India's trade balance reveals a comparative pattern broadly reflecting the country's progressive improvement in GDP per capita. India predominantly imports a basket of goods with high technological and productivity content, and exports products that embody a relatively low level of technology and productivity. However, one notable exception to this—already back in 1989/1990 and throughout the period of

observation—has been India’s solid comparative advantage in the production and export of medicaments.¹² Furthermore, the 2005/2006 *LFI* ranking shows clear evidence of industrial and technological upgrading among the top comparative advantage positions, most notably in relation to organic chemicals and passenger motor vehicles. These improvements are corroborated by the higher *HHR* productivity classification associated with the top *LFI* items in 2005/2006, testifying to the country’s partial success in moving up the development ladder, when measured along the level of GDP per capita associated with the export patterns of the world’s trading nations.

The evolution of India’s comparative advantage is further evidenced in Table 4, summarizing the values of *LFI* across goods by technology and productivity categories. According to the productivity measure (also visible from Figure 4), India has clearly managed to progressively improve its RCA pattern over time: whereas in 1989/1990 it had a strong comparative disadvantage in all goods but those pertaining to the lowest productivity category, by 2005/2006 it had managed to gain a position of comparative advantage in all goods but those associated with the top level of productivity. The improvement in India’s RCA position is somewhat less pronounced when measured along the average *LFI* across technological content and time. Indeed, the low-technology bias of India’s RCA pattern appears to be more persistent over time, with the exception of some reinforcement in the country’s position in a few middle-high technology sectors, showing up in the last period data.¹³ Indeed, Figure 3 shows low-technology products as the only category associated with a comparative advantage for India. A marked upward trend is recorded in the *LFI* of the medium and the medium-to-high technology categories since the late 1990s. By contrast, after a temporary improvement about the mid-1990s, high-technology items as a group have been on a downward path since the late 1990s, and continue to represent India’s greatest comparative disadvantage.

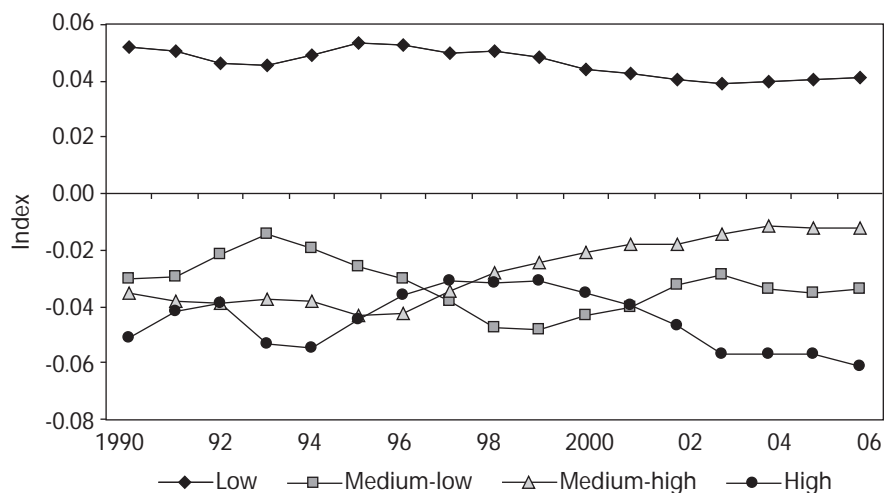
Table 4: Evolution of India’s Comparative Advantage by Technological Content and Productivity

Total LFI by Level of Productivity				
Year	*	**	***	****
1989/1990	16.83	-2.17	-6.29	-8.38
1997/1998	8.55	0.58	-2.92	-6.21
2005/2006	4.91	3.02	0.59	-8.52
Total LFI by Level of Technological Content				
Year	*	**	***	****
1989/1990	20.22	-5.88	-8.99	-5.35
1997/1998	19.72	-9.34	-7.11	-3.27
2005/2006	16.08	-6.69	-3.01	-6.39

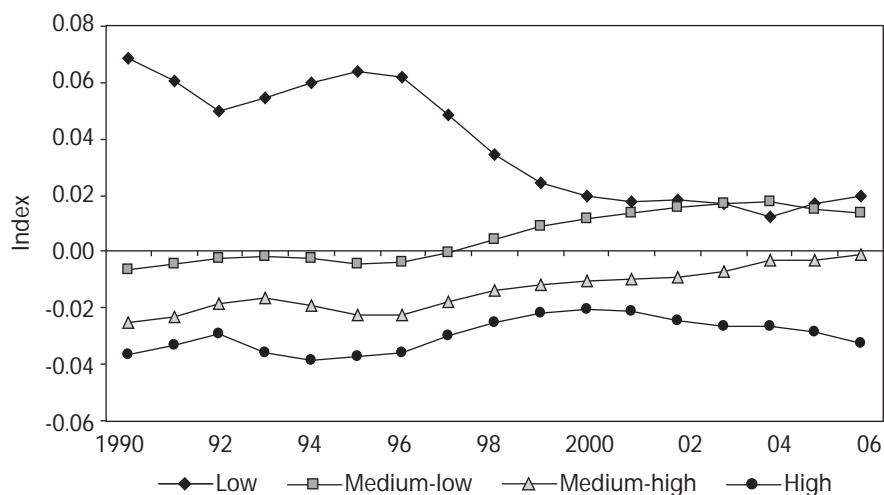
Source: Authors’ calculations are based on UN COMTRADE, OECD, and Penn World Tables.

¹² Of course, if trade in services were included in this paper’s analysis, certain services categories, including information technology, would probably top the rank of activities India has a comparative advantage in.

¹³ As mentioned above, these include mainly medicaments, passenger motor vehicles, and organic chemicals.

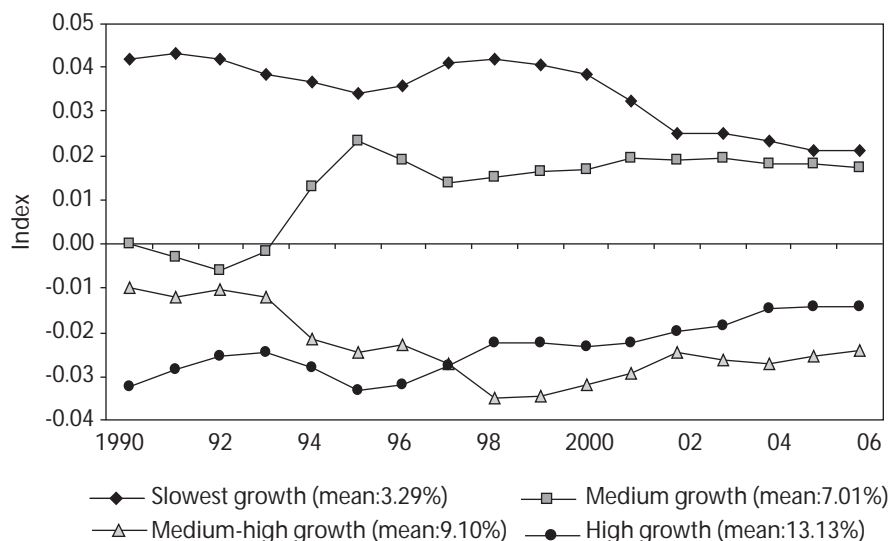
Figure 3: Average lafay Index by Technological Content, 1990–2006

Source: Authors' calculations based on UN COMTRADE and OECD data.

Figure 4: Average Lafay Index by Productivity, 1990–2006

Source: Authors' calculations based on UN COMTRADE and Penn World Tables.

Finally, India's *LFI* evolution is assessed in relation to the growth in world demand by product traded. Not surprisingly, Figure 5 confirms India that mainly specializes in items for which the growth in world demand is low. However, the country's revealed advantage in this category has been shrinking, at the same time as it has managed to maintain a solid advantage in the medium growth category, as well as gaining ground progressively in the two remaining categories. The evidence is thus of a slow and gradual shift of India's specialization pattern toward the more dynamic products in terms of world demand.

Figure 5: Average Lafay Index by World Demand, 1990–2006

Source: Authors' calculations based on UN COMTRADE data.

Overall, on the grounds of the preceding analysis, it may be concluded that India's RCA pattern has undergone a gradual upgrading over the period of observation. This is true both in terms of the level of productivity associated with the net balance of the goods it trades internationally and in the light of the establishment of a number of high-technology activities it has comparative advantage in. Moreover, India has managed to shift gradually toward specializing in products with more favorable dynamics in terms of world demand. However, this section also highlights that India's record since 1990, although remarkable, falls just short of a radical shift in the structure of its economy's revealed comparative advantage, testifying to the country's structure akin to that of a lower- to middle-income economy.

IV. Dynamic Panel Estimation of the Effects of Tariff Liberalization

Recent strands of trade theory have shown that firm-level heterogeneity plays a central role in the dynamic adjustment of industries to changes in trade policy. In a seminal contribution, Melitz (2003) shows that intra-industry trade results from endogenous changes in the structure of firms within industries. Each industrial sector is characterized by the presence of firms that differ with regard to their productivity and that act as monopolistic competitors à la Dixit and Stiglitz (1977). A move from autarky to free trade induces only the most productive firms to export. At the same time, the least productive

firms are forced to exit the industry. Both these effects lead to an improvement in sectoral productivity. Trade liberalization therefore exerts its effects through the endogenous self-selection of firms in each industry. Melitz and Ottaviano (2008) show that the benefits of trade liberalization are further enhanced through greater competition from an increase in market size.

The Melitz model has informed much of the recent debate on the dynamics of international trade. However, in its original version, the model does not allow for heterogeneity across sectors. This is addressed in an influential paper by Bernard, Redding, and Schott (2007). They assume production sectors to have different degrees of skill intensity, while countries as a whole are assumed to differ by factor endowment. Following the opening up of a country to foreign trade, a process of creative destruction of firms and jobs is set in motion. The creation of jobs is concentrated in the comparative advantage industries. Trade liberalization in these sectors creates export opportunities. This increases the *ex ante* profits in the industry and thus the incentive for new firms to enter, as well as raises the minimum level of productivity required for the survival of firms. These effects combined are more strongly pronounced in the sectors with comparative advantage, because these are where export opportunities increase the most. As a result, productivity gains are largest in firms featuring a comparative advantage.

To test empirically the main implications of the Bernard-Redding-Schott (2007) model for trade specialization in the case of India, dynamic equations are estimated for the industry-level Lafay index over 1990–2006. The index is regressed on the industry tariff rate and on variables that can be related to the determinants of their comparative advantage. The variables examined are the OECD index of technological content¹⁴ and the growth in world trade by industry. The index of technological content and the rate of growth of world output are interacted with the tariff rate, to capture the notion that changes in tariffs could have a different impact on trade specialization across industries characterized by different levels of technology and world demand.

The dynamic equation that is estimated can be written as:

$$LFI_{j,t} = \alpha(L)LFI_{j,t-1} + \beta(L)\tau_{j,t} + \gamma(L)(\tau_{j,t} \cdot Tech_j) + \delta(L)\Delta\tilde{y}_{j,t} + \theta(L)(\tau_{j,t} \cdot \Delta\tilde{y}_{j,t}) + \eta_j + v_{j,t} \quad (3)$$

where $LFI_{j,t}$ is the Lafay index of industry j at time t , $\tau_{j,t}$ is the tariff rate, $Tech_j$ is a vector of dummy variables for the industry technological content, $\Delta\tilde{y}_{j,t}$ is the 3-year average growth of world trade in industry i , η_j is the time-invariant unobservable industry-specific fixed effect, $v_{j,t}$ is an error term, and $\alpha(L)$, $\beta(L)$, $\gamma(L)$, $\delta(L)$ and $\theta(L)$ are vectors of polynomials in the lag operator.

Table 5 illustrates the results of the estimation of equation (3). The model has been estimated using the consistent Generalized Method of Moments estimator for dynamic

¹⁴ See the Data Appendix.

panel data proposed by Arellano and Bond (1991). The preferred specification in this paper contains four lags of the dependent variable and one lag each for the other regressors. Neither the Sargan test of over-identifying restrictions nor the test on the second-order autocorrelations of residuals are statistically significant, indicating that the suitability of dynamic specification cannot be rejected.

Table 5: Trade Specialization and Tariffs, Two-Step (Difference-Generalized) Method of Moments Estimation

Variables	D.lafay
LD.lafay	1.12636*** (0.00060)
L2D.lafay	-0.89365*** (0.00055)
L3D.lafay	0.55728*** (0.00059)
L4D.lafay	-0.18728*** (0.00040)
D.tariffs	0.00008*** (0.00001)
LD.tariffs	-0.00015*** (0.00001)
D.tariffs_tech_1	-0.00002* (0.00001)
LD.tariffs_tech_1	0.00006*** (0.00001)
D.growth	0.03961*** (0.00244)
LD.growth	-0.01393*** (0.00159)
D.tariffs_growth	-0.00085*** (0.00006)
LD.tariffs_growth	0.00042*** (0.00004)
Constant	-0.00020*** (0.00003)
Observations	11328
Number of ID	944
Arellano-Bond test that average autocovariance in residuals of order 1 is 0:	
z =	-3.3
Pr > z =	0.001
Arellano-Bond test that average autocovariance in residuals of order 2 is 0:	
z =	-1.36
Pr > z =	0.173
Sargan test of over-identifying restrictions:	
chi2 =	389.52
Prob > chi2 =	0.9818

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Source: Authors' estimations.

The sum of the regression coefficients on the tariff rate is negative. This implies that a reduction in tariffs is associated with an increase in the industry Lafay index. It would therefore appear that trade liberalization has a positive effect on trade specialization. This is consistent with the view that the reduction in tariffs is able to stimulate a process of dynamic reallocation within the industry that results in an improvement in its international competitiveness.

The impact of tariff reduction on trade specialization is however reduced in industries with a low technological content. The sum of the coefficients on the interaction between the tariff rate and the technological content is positive for low-technology industry. The overall effect of a decline in tariffs is however still positive even for these industries. Tariff reductions are therefore associated with an increase in specialization across all industries, but this effect is less strong for firms operating in industries characterized by low technological content.

The rate of growth of world trade by industry is introduced to capture the changes in the global demand for the industry output. An increase in world demand is associated with an increase in the specialization index over the lagged period. Interestingly, the sum of the coefficients of the interactions between growth in world trade by sectors and the tariff rate is negative. This suggests that tariff reductions tend to be associated with a greater increase in specialization in those industries that are growing faster in the global international trade.

The empirical findings on the changes in trade specialization in industries in India are broadly consistent with the view set out by Bernard, Redding, and Schott (2007) that industries respond differently to trade policy reforms. In general, a reduction in tariffs tends to be associated with an improvement in the degree of specialization, as captured by the Lafay index. The increase in the specialization index of industries following a reduction in tariffs tends to be larger for those industries characterized by growing world demand. At the same time, the beneficial effect of trade reforms appears to be lower for low-technology industries. Given the discussion in Section III, where it was documented that medium- to high-technology industries are still overwhelmingly underspecialized, this result might appear to be at variance with some of the predictions of the model by Bernard, Redding, and Schott (2007). According to this model, the beneficial effect of a tariff reduction should be greater in those industries with the greater comparative advantage. For India, these would still mostly be the low-technology industries. However, in Section III it has also been shown that the technological profile of trade specialization has undergone important shifts in the recent decades, and that high- and medium-technology industries have been gaining ground fast. This paper's results can therefore be explained in terms of a dynamic interpretation of the Bernard, Redding, and Schott (2007) model, whereby the benefits from trade liberalization are greater in those industries where the comparative advantage is already improving faster. This is consistent with the dynamic process of creative destruction of jobs and reallocation of resources within each industry that informs their model.

V. Conclusions

During the last couple of decades, India has experienced an important process of trade reform. Tariffs on imports were slashed and restrictions to trade were removed. How did the production structure of industries in India respond to this process of liberalization? This paper shows that the structure of comparative advantage of industries in India has substantially transformed during this period. The technological content of trade has shifted gradually from low-technology sectors toward medium-technology sectors. In addition, the profile of trade specialization has moved toward some of the most dynamic sectors in world trade.

More specifically, those industries where import tariffs have been reduced the most have experienced, on average, the largest improvements in their degree of intra-trade specialization. This is consistent with a view that trade liberalization promotes greater competition within the industry, and enhances the average productivity of firms in the sector. The increase in trade specialization has been greater in the industries characterized by medium- to high-technological content, and in the fastest-growing industries in world trade.

Trade liberalization policies can be controversial, since it is often feared that the exposure to foreign competition may place domestic firms at a disadvantage. While individual firms may have suffered from the liberalization policies, this paper's findings show that these policies have been instrumental in enhancing the international competitiveness of industries. This provides strong evidence in support of the trade liberalization policies India pursued since the early 1990s.

Data Appendix

The Lafay index

In this study, the Lafay index (*LFI*) is computed based on annual merchandise trade flow data from the United Nations COMTRADE database, covering 1990–2006. Data are disaggregated to the fourth digit of the Standard International Trade Classification Revision 3 (SITC-3) and encompass up to 945 product categories. To compute the *LFI*, missing trade flows were set to zero if either one of export and import flows are not zero and both the total export and import values are not zero. Moreover, to reduce the impact of outliers and year-to-year variations in exchange rates and prices, the index with trade flows taken at the 2-year average is computed.

Index of technological content

The taxonomy of technological content for sectors follows the Organisation for Economic Co-operation and Development (OECD) classification (see OECD 2001, Annex A). Sectors are classified according to research and development expenditure and output in 12 OECD countries over 1991–1999. Manufacturing industries are classified as low-technology, medium-low-technology, medium-high-technology, and high-technology. Since sectors are classified at three digits of the International Standard Industry Classification (ISIC), a concordance table available from the World Integrated Trade Solution (WITS) is used to convert the classification into SITC, and then map the data onto the 4-digit *LFI* table.

Index of productivity

The computation of the Hausmann-Hwang-Rodrik productivity index (*HHR*) relies on two sources of data. Trade flows are drawn from the UN COMTRADE database, accessed through the WITS, using SITC-3 to the fourth digit of cluster disaggregation. Data on per-capita gross domestic product are from the Penn World Tables 6.2 (Heston, Summers, and Aten 2006) at constant prices (2000 US\$). To avoid distortions in the calculation of *HHR*, all countries are dropped from the sample for which either trade or gross domestic product data is missing for any of the years during 2000–2002. This leaves us with a sample comprising 154 countries over the 3-year period of analysis. The *HHR* index is thus computed according to the specification provided in equation (2) of the text, for all the goods globally traded during 2000–2002, at the fourth digit of SITC-3.

Tariff data

The data source of India's applied weighted Most-Favored-Nation Tariffs is the United Nations Trade Analysis and Information System database (TRAINS). Tariff data for India are drawn at the fourth digit of the Harmonised System classification, which are converted to SITC by using the appropriate concordance table available from WITS. Tariff data are available for 1990, 1992, 1997, 1999, 2001, 2004, and 2005. Missing years are filled in simply by using the data for the latest year available (similar to Hallak and Schott 2008). Tariff data are reported as applied trade-weighted average (weighted by trade import values at the corresponding digit level).

(Note that for India there is no non-tariff barriers data available in the UN TRAINS database.)

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