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Trade in High Technology Products
Trends and Policy Imperatives for BRICS

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Abstract: This paper examines the emerging strength of BRICS in high-technology trade. We reviewed trends in high-technology trade primarily in BICS (excluding Russia). Given that China and India are leading exporters of High-tech products (HTPs) among BICS, changing patterns of intra-industry trade have been analysed at the disaggregated level for these countries. Trade denomination of Information Technology Products has been analysed as a special case to understand roles played by global trade agreements in influencing production and trade of high-technology goods. BRICS has also made significant progress in technology intensive trade in agriculture which is rarely captured in the analyses based on HTPs. The paper concludes with reflection on BRICS cooperation in global technology and trade governance for long term capacity building, industrial development and competitiveness.

Keywords: BRICS, High Technology Products (HTPs), Information Technology Agreement, International Trade, Intra-Industry trade

I. Introduction

The rise and relevance of BRICS (Brazil, Russia, India, China and South Africa) cannot be overstated. BRICS constitutes the most prominent emerging economies with substantial influence on world affairs – both political and economic. While China has demonstrated its capacity to be the world leader in production and trade, India and Brazil have been steady on rapid income growth and technological development backed by mature institutions and policy environment that tend to be oriented towards long-term economic development.[1] BRICS has become the

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fastest and largest emerging market economy and contributed 15.63 per cent to world's GDP at 2005 constant prices in 2013, with China and India accounting for 8.60 per cent and 2.64 per cent, respectively, followed by Russia (1.76 per cent), Brazil (2.06 per cent) and South Africa (0.57 per cent) (World Development Indicators). China and India have the potential to become the leaders in manufactured goods and services, Brazil in agricultural products, minerals and transport equipment, and South Africa in fuel and natural resources (Mohanty, 2008).

Evidence suggests that production and exports of high-technology products (HTPs) mainly in areas like electronic goods and computers have substantially shifted to the developing world. While BRICS has key strengths in production of high technology goods, China's volume and scale in some of the sectors are unmatched by others. This is evident from the fact that except China none has been able to generate surplus in terms of high-technology trade. China, on the other hand, has maintained a positive trade balance in HTPs and has become world leader in many segments. Other members of BRICS have key strengths in areas like pharmaceutical, biotechnology, and machinery. We take up a preliminary investigation into the status of high-technology products trade of BRICS countries to support their ongoing efforts towards gaining long-term competitiveness in these sectors. In this context, the role of global trade deals and international agreements in influencing production and trade of high-technology goods needs to be ascertained in order to arrive at useful policy analysis.

The financial crisis of 2007-08 had a negative effect on global trade. However, according to United Nations Industrial Development Organisation (2013), the impact on trade in manufacturing goods was proportionately less severe than on trade in fuels and mining products. Within manufacturing, high technology products make up for the largest share of trade in terms of value. In Section II we examine the trends in high-technology trade in the last decade which is also marked by gradual recovery from economic recession primarily driven by the emerging

countries including BRICS. We observe that GDP growth rates for India and China during 2010-14 lie between 7 to 8 per cent; for Brazil it was more than 3 per cent while South Africa and Russia grew at more than 2 per cent. Section III deals with detailed analysis of BRICS trade in HTP which includes overall exports and imports, and product specific/ destination-wise analysis. Given that China and India are the leading exporters in HTPs among the BRICS, hence the intra-industry trade between these two partners has also been analysed at the disaggregated level. Shares of exports of the Information Technology Products (ITAs) by BICS in HTPs are highest since 2005 and increased from 69 per cent to 78 per cent in 2014. In section IV we analyse the trade in ITAs for BICS (excluding Russia) with developed countries like Germany, Japan, South Korea, UK and US. Also, we have compared the US with China, particularly for semiconductors where US still holds 50 per cent of market share globally. BRICS countries have also made significant progress in technology intensive agricultural trade which is rarely captured in analysis based on HTPs. In the section V trade in biotech products is captured, given that BICS countries featured in top 10 countries in terms of global production.

II. Trade in High-Technology Products: Relative position of BRICS

On Defining HTPs

Technically, high-technology products (HTPs) are those goods that are outcomes of high levels of innovation and R&D. High technology goods constitute products that are either final products in themselves or serve as intermediate inputs. With increasingly distributed production structure spanning several locations and countries, those countries that are part of such production networks stand to gain according to their relative value addition. While intellectual assets generate maximum rent, manufacturing and assembly of products are equally important sources of income growth. Often production of high-technology goods in developing countries is of downstream nature. This helps advanced

economies to obtain substantial revenue generated out of sales of high-technology goods.

For accounting purposes, there have been several attempts at indentifying and classifying HTPs. Pavitt (1984) categorises industrial output as resource-based, labour intensive, differentiated and science-based manufactures. OECD (1994) presents an initial list corresponding to the 3-digit SITC Revision 3 classification of foreign trade. This was based on calculations about R&D intensity by groups of products (R&D expenditure/total sales) covering six countries (the United States, Japan, Germany, Italy, Sweden, the Netherlands) (cited in Hatzichronoglou, 1996). Following OECD (1994), Lall (2000) suggested a more detailed classification based on technological activity within each category. The scheme used in this study combines classifications by both Pavitt (1984) and OECD (1994), and extends them to take account of product groups or clusters of particular export interest to the developing world. In our analysis we make use of the product classification as proposed in Lall (2000). The product classification proposed in Lall (2000) is based on SITC at the 3-digit level (Revision 2) covering 18 product categories under high-technology (electronics, electrical machinery and others). Given that there was no difference in product codes at the 3-digit level between SITC (Revision 2) and SITC (Revision 3) we have used Revision 3 which is currently in use.

Based on Lall (2000), we have tried to estimate trends in high-technology trade with particular attention to BRICS. During 2005-2014, HTPs contributed close to one-fifth of the world's total trade of merchandise goods. However, world export of HTPs which was 21.39 per cent of total merchandise exports in 2005 gradually decreased to 18.04 per cent in 2014. Similarly, import of HTPs has declined from 21.71 per cent in 2005 to 18.26 per cent in 2014 (see Table 1). Interestingly, the share of OECD countries in the export of HTPs has drastically reduced from 76.4 per cent in 2000 to 45.4 per cent in 2014 (and for imports from 69.3 percent to 45.7 percent between 2000 and 2014).

Within BRICS we have focussed on Brazil, India, China and South Africa (BICS). We have excluded Russia for some part of the analyses since it is a high income economy within BRICS with much longer history of engineering.

Table 1: Share of High Technology Products in World Exports and Imports

Year	Share of HTPs in World Exports of Merchandise Products (%)	Share of HTPs in World Imports of Merchandise Products (%)	Share of HTPs in World's Total Trade in Merchandise Products (%)
2005	21.39	21.71	21.55
2006	21.00	21.30	21.15
2007	19.79	20.00	19.90
2008	18.10	18.41	18.26
2009	19.77	20.50	20.13
2010	19.48	20.87	20.18
2011	17.87	18.76	18.32
2012	18.41	19.07	18.74
2013	18.59	19.41	19.00
2014	18.04	18.26	18.15

Source: Authors' calculations based on data obtained from WITS online.

At the same time, contribution of BRICS in trade in HTPs has significantly improved during the period. The total exports of HTPs from BRICS was USD 272.02 billion in 2005 and increased almost threefold to USD 775.14 billion in 2014 as shown in Table 2. Similarly, imports increased from USD 286.25 billion to USD 634.75 billion between 2005 and 2014, suggesting more than two-fold increase during the decade. During the first five years (i.e. 2005-09), the average positive trade balance in HTP for BRICS was USD 14.18 billion while in the second phase (i.e. 2010-14) there was a sharp increase in the quantum of trade surplus in HTPs for BRICS at an average of USD 86.38 billion per year (see Table 2).

Table 2: BRICS's Trade of HTPs with the World (Average)

Year	Exports (USD billions)	Growth (%)	Imports (USD billions)	Growth (%)	Trade Balance (USD billions)
2005	272.02		286.25		-14.23
2006	347.14	27.61	357.01	24.72	-9.87
2007	433.22	24.8	409.55	14.71	23.68
2008	490.37	13.19	456.36	11.43	34.01
2009	442.01	-9.86	404.7	-11.32	37.31
2010	578.1	30.79	522.95	29.22	55.15
2011	653.47	13.04	580.1	10.93	73.37
2012	707.97	8.34	631.02	8.78	76.94
2013	776.34	9.66	690.3	9.39	86.04
2014	775.14	-0.15	634.75	-8.05	140.39
Average					
2005-09	396.95	11.15	382.77	7.91	14.18
2010-14	698.2	12.33	611.83	10.05	86.38

Source: Authors' calculations based on data obtained from WITS online.

High technology exports from BRICS shrunk in 2009 due to global recession. This trend was reversed in the following years. In 2014 exports of high technology products from BRICS squeezed marginally. Moreover, the immediate recovery in exports of high technology products from BRICS in 2010, as is evident from Table 2 was largely due to China's trade surplus of USD 138.4 billion in 2010 (Table 3). Among the BICS countries, one cannot ignore the overwhelming contribution of China's exports of HTPs to the world. China is the only country which recorded positive trade balance all through during the period under consideration as shown in Table 3.

Table 3: Trade Balance of BICS Countries for High Technology Products (2005-2014) (USD billions)

	Brazil			India			China			South Africa		
Years	**X**	**M**	**X-M**	**X**	**M**	**X-M**	**X**	**M**	**X-M**	**X**	**M**	**X-M**
2005	9.21	14.65	-5.44	3.06	16.65	-13.59	253.85	234.10	19.75	1.96	9.55	-7.59
2006	10.23	18.21	-7.98	4.10	23.53	-19.43	326.68	287.64	39.03	2.17	10.18	-8.00
2007	11.17	15.41	-4.24	5.21	25.95	-20.74	409.69	331.54	78.15	2.42	11.40	-8.98
2008	13.23	29.93	-16.69	8.07	34.31	-26.23	461.25	346.58	114.67	2.49	12.70	-10.21
2009	9.95	24.08	-14.13	11.45	33.30	-21.84	414.14	315.21	98.93	1.81	10.12	-8.31
2010	10.00	32.92	-22.92	10.38	34.82	-24.45	549.52	411.12	138.40	2.55	13.13	-10.57
2011	10.17	36.92	-26.75	15.00	40.31	-25.31	619.07	451.41	167.66	2.99	15.34	-12.35
2012	10.69	37.50	-26.81	13.38	40.11	-26.73	672.53	494.33	178.21	3.04	14.11	-11.07
2013	9.43	40.05	-30.63	16.57	41.41	-24.84	737.45	549.54	187.91	2.84	14.82	-11.98
2014	8.68	37.95	-29.27	16.83	42.67	-25.84	746.37	540.01	206.36	3.27	14.14	-10.86

Note: X stands for Exports, M stands for Imports and X-M stands for Trade Balance.

Source: Authors' calculations based on data obtained from WITS online.

III. BRICS Trade in HTPs

BICS's Export to the World

China registered the fastest growth in terms of export of HTPs among the BICS nations. China's share of exports of HTPs to the world's total export was 11.67 per cent in 2005 and grew three times to 35.12 per cent in 2014 as shown in the Table 4. China consistently held the top position among BICS in share in global export of high technology products during the period of 2005-2014. India's export of HTP increased from USD 3.06 billion in 2005 to USD 16.83 billion in 2014. Interestingly, China's share in exports of high technology products to the world improved substantially even during the period of recession. India's share in global exports of high technology goods is below one per cent (slightly better than the other two). Brazil and South Africa are emerging in HTPs exports. Brazil has had an irregular performance till 2008 which was

well below its potential. South Africa's share in world's export of HTPs is still insignificant and has been constant at 0.09 per cent since 2005. However, unlike Brazil, South Africa's share has been growing at a much faster rate over the period. We observe that, the share of the US in high technology exports has been declining during 2005-13. The share of the BICS in high technology exports has exceeded that of the US in the last ten years primarily driven by the phenomenal increase in exports of such products by China.

BICS's Import from World

China attracted more than one fifth of the world's imports of high technology products in 2014; whereas India's share was 1.81 per cent, Brazil's 1.61 per cent and South Africa's 0.60 per cent as shown in the Table 5. In the span of ten years from 2005 to 2014, Brazil's share in world's import of high technology products increased from 0.64 per cent in 2005 to 1.61 per cent in 2014, growing at a CAGR of 10 per cent per annum. China's imports of high technology goods doubled from USD 234.1 billion in 2005 to USD 540.01 billion in 2014 (CAGR of 8.72 per cent). Much of China's imports of HTP must have contributed to China's export of high-technology goods. India's import of high technology goods was also growing at a similar pace with that of Brazil (CAGR of 9.87 per cent between 2005 and 2014) whereas for South Africa imports of high-technology goods registered only a modest growth. When we compare BICS's import of HTPs with that of the US we find a gradual increment in BICS share over the ten years period. In 2014, we observe sharp rise in the share of imports of HTPs both in BICS and in the US suggesting possible decline of import of HTPs by some countries.

Top Exports and Destinations

We examined the composition of export basket of BICS countries in HTPs in 2005 and in 2014 (Table 6). Interestingly, China showed little variation in its top high technology exports. China is observed to have specialised primarily in telecommunication equipment, computers, semiconductors and electrical equipment. Almost 50 per cent of the China's HTPs exports

Table 4: Value and Share of BICS Countries' Exports of HTP in World's Total Export of HTPs

Years	Brazil		India		China		South Africa		BICS		US	
	Value (USD billions)	Share (%)	Value (USD billions)	Share (%)	Value (USD billions)	Share (%)	Value (USD billions)	Share (%)	Value (USD billions)	Share (%)	Value (USD billions)	Share (%)
2005	9.21	0.42	3.06	0.14	253.85	11.67	1.96	0.09	268.09	12.33	242	11.13
2006	10.23	0.41	4.1	0.16	326.68	13.09	2.17	0.09	343.18	13.75	279.07	11.18
2007	11.17	0.42	5.21	0.19	409.69	15.26	2.42	0.09	428.49	15.96	292.28	10.89
2008	13.23	0.47	8.07	0.28	461.25	16.25	2.49	0.09	485.04	17.09	296.69	10.45
2009	9.95	0.41	11.45	0.47	414.14	17.15	1.81	0.08	437.35	18.11	199.92	8.28
2010	10	0.34	10.38	0.36	549.52	18.94	2.55	0.09	572.45	19.73	232.08	8
2011	10.17	0.32	15	0.47	619.07	19.58	2.99	0.09	647.22	20.47	242.75	7.68
2012	10.69	0.33	13.38	0.42	672.53	21	3.04	0.09	699.64	21.84	250.61	7.82
2013	9.43	0.28	16.57	0.5	737.45	22.11	2.84	0.09	766.29	22.98	252.16	7.56
2014	8.68	0.41	16.83	0.79	746.37	35.12	3.27	0.15	775.14	36.47	262.86	12.37
CAGR	-0.6		18.58		11.39		5.24		11.20		0.83	

Source: Authors' calculations based on data obtained from WITS online.

Table 5: Value and Share of BICS Countries' Imports of HTPs in World's Total Import of HTPs

Years	Brazil		India		China		South Africa		BICS		US	
	Value (USD billions)	Share (%)	Value (USD billions)	Share (%)	Value (USD billions)	Share (%)	Value (USD billions)	Share (%)	Value (USD billions)	Share (%)	Value (USD billions)	Share (%)
2005	14.65	0.64	16.65	0.73	234.1	10.3	9.55	0.42	274.95	12.09	303.31	13.34
2006	18.21	0.71	23.53	0.91	287.64	11.16	10.18	0.39	339.56	13.17	333.44	12.93
2007	15.41	0.55	25.95	0.93	331.54	11.92	11.4	0.41	384.30	13.82	356.95	12.84
2008	29.93	1.01	34.31	1.16	346.58	11.71	12.7	0.43	423.52	14.32	364.07	12.31
2009	24.08	0.95	33.3	1.32	315.21	12.45	10.12	0.4	382.71	15.12	320.91	12.68
2010	32.92	1.05	34.82	1.11	411.12	13.1	13.13	0.42	491.99	15.68	384.17	12.24
2011	36.92	1.1	40.31	1.2	451.41	13.4	15.34	0.46	543.98	16.15	416.8	12.37
2012	37.5	1.11	40.11	1.19	494.33	14.67	14.11	0.42	586.04	17.40	431.81	12.82
2013	40.05	1.15	41.41	1.19	549.54	15.76	14.82	0.43	645.83	18.52	439.25	12.6
2014	37.95	1.61	42.67	1.81	540.01	22.95	14.14	0.6	634.75	26.98	462.43	19.65
CAGR	9.99		9.87		8.72		4		8.73		4.31	

Source: Authors' calculations based on data obtained from WITS online.

were in telecommunication equipment and computer equipment in 2014. Both Brazil and India have been exporting aircraft related technologies and this constitutes significant export earnings for both the countries (above 40 per cent share in HTPs in 2014). Other product categories like electrical machinery, equipment and instruments also featured among top exports in HTPs from Brazil and India. The export basket of South Africa in high technology is not very different from other BICS countries. Exports of telecommunication equipment and aircraft contribute almost one third of the South Africa's exports of HTPs in 2014. Our data testifies the fact that pharmaceutical products are one of the most important exports under high-technology category from India. Even Brazil's export of pharmaceutical products is significant at 5 per cent in 2014. Further detailed account for top 5 HTP exports in 2014 for BICS is given in Table A1 in Appendix 1.

We consider the top ten export destination partners of BICS countries in HTPs for the years 2005 and 2014 (see Table A2 in Appendix 1). Developed countries like US, Japan, South Korea, and Germany are among the top export partners of China. In 2005 and in 2014, China's export destinations in HTPs have almost been the same, except the fact that India featured in the top ten in 2014 (India was China's 12th major export partner in HTPs in 2005). However, Brazil and South Africa are much less important export destinations for China's HTPs. In 2005, in the order of importance, Brazil was 24th and South Africa was 33rd; their relative position in this regard has improved since then with Brazil coming up to the 16th position and South Africa at 30th. This reflects increasing trade among the BICS countries in HTPs.

Sri Lanka has come up as the top exporting partner of India in 2014 with USD 2055.62 million in HTPs from 24th position with USD 33.15 million of exports in 2005. In 2005 most of India's exports in HTPs were meant for the US market. However, during this period in absolute terms high technology export to US has increased threefold. India's exports of HTPs to United Arab Emirates have increased significantly from

Table 6: Top 5 High-Technology Products Exported by BICS Countries to World in 2005 and 2014

	Brazil		India	
	2005	**2014**	**2005**	**2014**
1	Aircraft/ Spacecraft	Aircraft/ Spacecraft	Medicinal Pharmaceutical Products	Aircraft/ Spacecraft
2	Telecommunication Equipment	Rotating Electrical Plant	Electrical Equipment	Medicinal Pharmaceutical Products
3	Rotating Electric Plant	Electrical Equipment	Electric Power Machinery	Telecommunication Equipment
4	Electrical Equipment	Medicinal Pharmaceutical Products	Rotating Electric Plant	Electrical Equipment
5	Computer Equipment	Measure & Control Apparatus	Medical electro diagnostic equipment	Electric Power Machinery
	China		**South Africa**	
	2005	**2014**	**2005**	**2014**
	Computer Equipment	Telecommunication Equipment	Aircraft/ Spacecraft	Telecommunication Equipment
	Telecommunication Equipment	Automatic Data Process Equipment	Telecommunication Equipment	Aircraft/ Spacecraft
	Office Equipments Parts	Valves/transistors/ etc	Other inorganic Chemical	Measure & Control Apparatus
	Valves/transistors	Electrical Equipment	Electrical Equipment	Electrical Equipment
	Electrical Equipment	Office Equipments Parts	Measure & Control Apparatus	Television Receivers

Source: Authors' calculations based on data obtained from WITS online.

USD 153.15 million in 2005 to USD 1839.04 million in 2014. China was among the top five exporting partners of India in 2014 and exports of HTPs grew from USD 101.93 million in 2005 to USD 757.6 million in 2014. Other major export partners of India are Singapore, Germany, UK and France.

The United States and Argentina have been the top export destinations of Brazil in both 2005 and 2014. Brazil's exports of HTPs to US, Argentina and Germany has declined in terms of value in the ten year period. Brazil's exports to Mexico and China has increased significantly and ranked third and fourth respectively, in the list of top ten exporting partners in 2014. Our data shows that there is a significant enhancement in trade among emerging economies as China ranked fourth for both India and Brazil in the list of top ten export partners in 2014. Brazil's export of hi-tech products to India has been uneven and has declined from USD 182.44 million in 2005 to USD 86.02 million in 2014.In 2005, India was the top exporting partner of South Africa but unfortunately in 2014 it fell to the 17th position. US was holding 2nd position in South Africa's trade of HTPs in 2005 with the export value of USD 163.59 million but it also fell to 5th position in 2014 with a marginal increase of USD 23.64 million. In 2005 South Africa's top exporting partners for HTPs were mainly developed countries but in 2014 they continue to export primarily to the LDCs in Africa.

Intra-BRICS Trade in High Technology Goods

Intra-BRICS export of high technology goods has been propelled mainly by China and India (Table A3 in Appendix). Between 2005 and 2014, export of HTPs from China and India to BRICS grew close to 20 per cent. China's export of HTPs grew at equal rates with India, Brazil and South Africa (CAGR of around 18 per cent). Similarly, India's export of high tech products increased almost at similar rates with China, Brazil and Russia. Value of Chinese exports of HTPs to all other four BRICS countries is very high and growing in the range of 18 to 20 per cent. Within BRICS, India has been an important exporting partner of China as the share of trade is highest.

Similarly for India, China is a leading export partner in HTPs with incremental increase in intra-industry trade. Russia is another top destination for India's HTPs among BRICS countries. In 2014, China and Russia attracted almost 75 per cent of India's high tech exports to

BRICS. Looking at the GL record, South Africa and Russia are the main intra-industry trading partners of India in HTPs. Brazil is emerging as an important intra-industry trading partner of India in HTPs.

Brazil's exports of HTP to BRICS grew marginally between 2005 and 2014 (3.7 per cent). In terms of the value of the trade, China and India are the major partners of Brazil and their share is more than 80 per cent in 2014. India and Russia are the major intra-industry trading partners of Brazil as mirrored in the GL index. In case of South Africa, contribution in intra-industry BRICS exports of HTPs is very low.

Intra-Industry Trade in High Technology Goods among BRICS: Disaggregated View

In order to investigate intra-industry trade of HTPs among BRICS at the level of commodity groups, we look at 18 HTP categories at SITC 3 digit for the period of 2005 to 2014. Since China and India are the leading exporters in HTPs among BRICS countries our commodity-wise analysis mainly focusses on China and India. We focus mainly on China and India and their roles in influencing intra-BRICS trade in HTPs. Commodity-wise analysis of HTPs among BRICS due to China and India are based on calculation of GL index which is given in Tables A4- A11 in Appendix 1.

To capture the extent of intra-BRICS trade in HTPs under specific product categories, we have calculated the simple Grubel - Lloyd (GL) index[2] represented as,

$$GL_j = \sum\{(X_{ij} + M_{ij}) - \sum|X_{ij} - M_{ij}|\} / \sum (X_{ij} + M_{ij}) * 100$$

Where GL_j is the average level of intra-industry trade for a country j, X_{ij} is the export of commodity i of country j, M_{ij} is the import of commodity i of country j and summation is over the commodity i. To facilitate comparison of index values for different countries, in our case over the period of ten years, it is useful to express the index as percentage.

In terms of volume of exports, China's exports to Brazil are concentrated in three commodities: telecommunications equipment (SITC 764), electrical equipment (SITC 778) and optical instruments (SITC 871). Currently, China exports USD 2.7 billion in telecommunication equipment (SITC 764), USD 1.14 billion in electrical equipment (SITC 778) and USD 1.1 billion in optical instruments (SITC 871) to Brazil. In our analysis we have found that China's intra-commodity trade in rotating electric plant (SITC 716) and measure and control apparatus (SITC 874) with Brazil has significantly declined since 2005. Between China and Brazil, GL Index for power generating equipment (SITC 718) increased from 22.85 per cent in 2005 to 88.94 per cent in 2008 and but thereafter declined to 7.61 per cent in 2014.

China's exports to India in terms of volume of exports in HTPs are highest for the commodities like telecommunications equipment (SITC 764) and computer equipment (SITC 752) since 2005. Exports of China to India has increased significantly for some commodities like power generating equipment (SITC 718), optical instruments (SITC 871) and aircraft /spacecraft (SITC 792) with CAGR of more than 40 per cent. China's intra-commodity trade with India in medicinal and pharmaceutical products (SITC 541) has been declining from 33.56 per cent in 2005 to 8.41 per cent in 2014. Similarly, GL index for valves/ transistors etc (SITC 776) has declined from 48.94 per cent in 2005 to 7.29 per cent in 2014. We have seen some remarkable results in intra-commodity trade between India and China in electro diagnostic equipment for medicinal purposes (SITC 774). For this product category, during the intervening period the index has always been close to 80 to 90 per cent. Similarly, as in the case of China's trade with Brazil, China's intra-commodity trade in power generating equipment (SITC 718) with India has shown a declining trend as the index fell from 89.33 per cent in 2005 to 28.53 per cent in 2014.

China's exports to South Africa and Russia are mainly in four commodities: telecomm equipment (SITC 764), computer equipment (SITC 752), television receivers (SITC 761), and electrical equipment

(SITC 778) accounting for 70 per cent of high tech exports. In case of China's intra-commodity trade with South Africa and Russia, our analysis has indicated that there is no intra-commodity trade for most of the products like office machines (SITC 751), computer equipment (SITC 752), office equipment and parts (SITC 759), television receivers (SITC 761), telecommunication equipment (SITC 764), and electrical equipment (SITC 778) during the period. High intra-commodity trade is only observed for other inorganic chemicals (SITC 524) with significantly high GL index for South Africa and Russia.

Between 2005 and 2014, India's exports to China have increased significantly for four commodities: television receiver (SITC 761) which grew from USD 0.056 million in 2005 to USD 2.49 million in 2014, rotating electric plant (SITC 716), telecommunications equipment (SITC 764) and power generating equipment (SITC 718) (CAGR > 35 per cent, since 2005). India's intra-industry trade with China has been most significant for medical electro diagnostic equipment (SITC 774) (GL index close to 80 per cent before recession and above 60 per cent after recession). The GL index has reduced significantly for optical instruments (SITC 871) and office machines (SITC 751), from 38.33 per cent in 2005 to 0.43 per cent in 2014 and from 14.21 per cent in 2005 to 0.17 per cent in 2014, respectively. We have noticed a wide fluctuation in intra industry trade between India and China for aircraft/ spacecraft (SITC 792) in the last ten years as the index was at its peak in 2009 at 98 percent and declined to 4.84 percent in 2014. Products such as computer equipment (SITC 752), office equipments parts (SITC 759) and television receivers (SITC 761) have an index close to zero in recent periods. This is mainly due to China's high volume of exports to India in these categories.

India's exports of pharmaceutical products (SITC 541) to Brazil has increased significantly from USD 16.73 million in 2005 to USD 141.04 million in 2014. India's exports to Brazil in the commodities like other

inorganic chemical (SITC 524) and photographic equipment (SITC 881) has shown a drastic decline at a CAGR of –14 per cent since 2005. India's intra-industry trade with Brazil for the electrical equipment (SITC 778) and measure and control apparatus (SITC 874) has always been on the higher side since 2005. Commodities like telecommunications equipment (SITC 764), office machines (SITC 751) and pharmaceutical products (SITC 541) have shown a significant increase in intra-industry trade between India and Brazil from 2005 to 2014. Some other commodities like valves/transistors, etc., (SITC 776), electro diagnostic equipment for medicinal purposes (SITC 774), power generating equipments (SITC 718) and rotating electrical plants (SITC 716) have also registered increasing trend in intra-industry trade between India and Brazil.

India's export of stream/vapour turbines (SITC 712) to South Africa has grown from USD 0.006 million in 2005 to USD 2.47 million in 2014. In 2014, exports of telecomm equipment (SITC 764) and electrical equipment (SITC 778) made up for almost 50 per cent of India's exports to South Africa. India's intra-industry trade with South Africa in office equipment (SITC 759) is higher among all the HTPs since 2005 except during the recession years. Commodities like television receivers (SITC 761) and telecommunications equipment (SITC 764) have shown an increasing trend for intra-industry trade between India and South Africa during these ten years. Valves/ transistors (SITC 776), electric power transmission equipment (SITC 771) and computer equipment (SITC 759), however, have shown a significant decline in intra-industry trade between India and South Africa in the last ten years.

India's exports of HTPs to Russia mainly comprise two products, viz. aircraft/spacecraft (SITC 792) and telecommunications equipment (SITC 764) whose share in total high tech exports from India to Russia stood in the range of 50 to 70 per cent during the period 2005-09. This share further went up to the range of 70 to 90 per cent during the period 2010-14. Export of telecommunications receiver (SITC 761) has grown

significantly at CAGR of 109.35 whereas export of stream/vapour turbines (SITC 712) and computer equipment (SITC 752) has declined since 2005. India's intra-industry trade with Russia has declined for various products like television receivers (SITC 761), pharmaceutical products (SITC 541), other inorganic chemicals (SITC 524), optical instruments (SITC 871), office machines (SITC 751) and office equipment (SITC 759). Rotating electrical plant (SITC 716) and valves/transistors (SITC 776) have been highly traded high tech products between India and Russia in recent years.

IV. BRICS Trade in Information Technology Products

The Ministerial Declaration on Trade in Information Technology Products (ITA) was concluded by 29 participants at the Singapore Ministerial Conference of the WTO in December 1996. The number of participants has grown to 82, representing about 97 per cent of world's trade in information technology products. The ITA provides for participants to completely eliminate duties on IT products covered by the Agreement. Developing country participants were granted extended periods for some products. ITA, which was a post-1995 development in terms of a new sector specific multilateral trade deal under the WTO, had effectively fulfilled the criteria of 90 per cent of world trade in IT products in 1997. The initial agreement does not, however, include provisions on non-tariff issues. In doing so, ITA proactively sought enhanced market accesses for IT products by eliminating tariffs for such products. While India joined ITA in 1997 itself, China did so in 2003 after its accession into the WTO in 2001. The other two prominent BRICS members Brazil and South Africa are yet to join ITA. Russia has very recently joined ITA as part of its accession to the WTO.

Evidence based on data try to justify the relevance of ITA in expanding trade in IT products phenomenally. Global trade in the information technology and electronic products doubled over the period 1997 to 2005, totalling over USD 1.4 trillion (WTO, 2007). The share of IT products in world merchandise exports in 2010 was 9.5 per cent

which is more than trade in all agricultural products (9.2 per cent) and automotive products (7.2 per cent) (Maurer, 2012).[3]

Estimations presented in our analysis are based on 150 IT products as per Ministerial Declaration on Trade in Information Technology Products, 1996 (WT/MIN (96)/16). The IT products in the original agreement are classified under two lists called Attachment A and Attachment B. The Attachment A lists the HS headings or parts thereof to be covered and Attachment B lists specific products to be covered by ITA wherever they are classified in the HS. Again under Attachment A there are two sections. Section 1 covers IT products and includes 112 items corresponding to 110 HS 1996 Subheadings (i.e.6-digits). Section 2 covers semiconductor manufacturing and testing equipment parts (78 items) that correspond to 45 HS 1996 Subheadings. Of these, 42 items are labelled "For Attachment B". The total number of items in Sections 1 and 2 adds up to 190 products. Without the 42 items labelled for Attachment B, the number of products stands at 148.

China's export for IT products was way behind developed countries like US, UK, Germany, Japan, and South Korea in 1996 (Table 7). However, China overtook the United States in 2004 to become the world's leading exporter of information and communications technology (ICT) goods such as mobile phones, laptop computers and digital cameras (OECD). China remains the world's top exporter of all main categories of ICT goods. China is also the top importer of ICT goods, accounting for 18 per cent of world imports and 34 per cent of all electronic component imports, including re-imports from Hong Kong (China) (UNCTAD, 2014). Economies in East and South East Asia remain among the only net exporters of ICT goods. All other developing and transition economies represented a very modest share of global ICT goods trade, with 4 per cent of total exports and about 8.5 per cent of total imports (UNCTAD, 2014). The growth of China's export of information technology goods was fastest during 2005-10. On the other hand, growth of US exports of IT products has slowed down compared to 1996-2000. BICS share for

export in IT products is three times higher than US in the year 2014. This is mainly due to the overwhelming contribution of China. The share of other BICS countries is very low, with India having a larger contribution than other two countries. Also, export of IT products has seen a relative decline in UK, Germany and Japan in recent years.

Table 7: Exports of Information Technology Products of Selected Countries (USD billions)

Country	1996	2000	2005	2010	2011	2012	2013	2014
Brazil		1.95	3.91	2.44	2.58	2.58	2.00	1.65
India	0.72	0.84	1.87	5.83	8.81	7.81	7.36	5.23
China	11.85	31.77	180.38	418.19	476.28	524.35	590.19	594.83
South Africa		0.52	0.70	1.23	1.45	1.56	1.47	1.66
BRICS	**12.57**	**35.08**	**186.86**	**427.69**	**489.12**	**536.3**	**601.02**	**603.37**
Germany	47.61	63.14	109.40	112.34	125.91	113.49	116.23	
Japan	94.96	131.07	134.97	137.05	137.61	127.07	107.81	105.41
South Korea	24.07	49.99	79.69	107.80	111.79	109.21	126.07	
United Kingdom	39.46	54.91	58.30	31.51	32.88	28.80	29.93	31.28
United States	127.45	192.75	162.25	176.83	183.84	185.48	187.86	195.19

Note: Calculations are based on ITA Product List (Attachment A, Sections 1 and 2) in HS 1996.

Source: Authors' calculations based on data obtained from WITS online.

China's import of IT products was very low when compared with US, UK, Germany, South Korea and Japan till 2005. China's import of IT products have risen after 2005 and stands higher than that of US and other developed countries like Germany, Japan, and UK. Aggregate share of imports for BICS is increasing mainly due to China's massive participation in IT products. China's imports of IT products show a marginal decline from USD 462.85 billion in 2013 to USD 454.23 billion in 2014. US imports for IT products has marginally grown from USD 265.58 billion in 2010 to USD 324.68 billion in 2014.

Table 8: Imports of Information Technology Products of Selected Countries (USD billions)

Country	1996	2000	2005	2010	2011	2012	2013	2014
Brazil		9.21	10.15	20.77	24.75	24.58	26.17	25.10
India	1.60	3.32	12.36	25.09	31.60	30.12	30.93	32.92
China	19.52	49.29	189.29	339.34	381.82	410.48	462.85	454.23
South Africa		3.65	6.41	8.34	9.52	9.02	10.19	9.12
BRICS	**21.12**	**65.47**	**218.21**	**393.54**	**447.69**	**474.2**	**530.14**	**521.37**
Germany	44.67	63.69	99.72	109.39	118.46	102.94	102.38	
Japan	46.26	65.66	73.34	84.35	91.16	97.24	97.70	100.51
South Korea	25.92	41.56	55.16	74.53	78.33	72.05	73.66	
United Kingdom	43.54	69.95	64.74	56.10	59.38	52.27	54.55	57.28
United States	132.80	209.83	215.15	265.58	292.40	301.93	309.01	324.68

Note: Calculations are based on ITA Product List (Attachment A, Sections 1 and 2) in HS 1996.
Source: Authors' calculations based on data obtained from WITS online.

The US has been one of the biggest beneficiaries of the ITA. Not only did US exports in particular product categories like semiconductor increase (US presently holds 50 per cent market share in semiconductors globally) after ITA was adopted by the signatories, ITA also provided a big push to the expansion of Global Production Networks (GPNs) of US ICT companies (Ernst, 2014). US Multinational Companies (MNCs) were increasingly investing in manufacturing in low cost countries like China. EU and Japan have been ahead in manufacturing and innovations of IT products and are aggressive players in ITA.

In 2000, US exports in semiconductors were USD 29.47 billion, while that of China was still low at USD 1.12 billion. Overtime, China's exports in semiconductors have steadily increased (except when the global recession manifested itself the most when it declined from USD 12.55 billion in 2008 to USD 10.44 billion in 2009). The US also suffered significant erosion in exports of semiconductors at the onset of the recession (from USD 28.85 billion in 2008 to USD 21.28 billion

in 2009). However, immediately after recession US has been able to recover at much faster rate in terms of exports in semiconductors than China. According to the latest available figure, there was still a gap of USD 10.74 billion between the two countries, with US lying significantly ahead of China (see Table 9).

Table 9: Exports of Semiconductors of China and USA (USD billions)

Year	China	USA
2000	1.12	29.47
2001	1.27	21.32
2002	1.52	18.24
2003	2.19	18.19
2004	3.35	26.14
2005	4.74	25.73
2006	6.45	30.87
2007	9.53	33.23
2008	12.55	28.58
2009	10.44	21.28
2010	14.32	32.62
2011	16.67	31.96
2012	18.94	31.56
2013	20.02	31.96
2014	23.53	34.27

Note: Calculations are based on ITA Product list in HS 1996 (Attachment A, Sections 2).

Source: Authors' calculations based on data obtained from WITS online.

Nevertheless, China has benefitted most among developing countries in terms of production and export of IT goods. It continues to remain the top source of such products globally. Some studies try to argue that countries that joined the ITA after 1997 benefitted more in terms of expansion in trade in IT products than the original participants. China, which joined ITA in 2003 with already high levels of trade in IT goods, was outlier among developing countries. China's importance in trade

of ITA products has increased immensely on the export side, and, to a lesser extent, on the import side. While China is not very distinct in its import pattern from other countries, it has become an exceptional case of export success in ITA products since its accession to the agreement (Henn and Gnutzmann-Mkrtchyan, 2015).

However, over the years there has been mixed response on the benefits of ITA in the developing world. While emerging economies have registered steady growth in national income, apart from China growth in trade in IT products has not been noteworthy beyond some countries of East Asia like South Korea, Taiwan, Malaysia, Thailand and Singapore. Though latecomers, as many others in the developing world, these are countries that have evolved as important nodes of Global Production Networks (GPNs) in IT products. In BRICS, China has outperformed the rest in IT trade. Countries that are part of ITA but have a limited manufacturing base in electronics and equipment blame it on the ITA that cheaper imports have contributed to the decline of the domestic electronics and equipments industry. This has been the case with India. At the same time large economies like Brazil with significant strengths in segments of high-technology manufacturing have stayed away from such agreements citing potential vulnerabilities. ITA as part of WTO is fervently seeking to expand its membership in the Latin American region. Proponents have often referred to substantial contributions of IT goods in facilitating production in other sectors that get reflected in overall growth of income and consumption in many countries.

ITA goes beyond the original structure of GATT that encouraged compliance among member countries in terms of bound and applied rates of custom duties. The applied rates in most cases were much lower than the bound rates. Founding members of the ITA were to implement zero tariffs by 2000, but some developing countries had longer implementation periods (latest by 2005). The commitments undertaken are of the MFN nature and hence benefit all WTO members. Such provisions had to be incorporated in the commitment schedules to the GATT by member

countries. The ITA also required that each member should provide all other participants details of ensuing measures and product coverage (WT/MIN(96)/16). The initial product coverage included 190 products as per HS 1996 6-digit product codes. The original list adopted in 1997 has undergone some revisions in 2000 primarily to accommodate revised definitions of products as communicated by the World Customs Organisation (WCO) that oversees HS Classification codes. The main chapters under HS 1996 classification include 84, 85 and 90 with very few products from some of the other chapters. Chapter 84 included appliances, chapter 85 included electrical machinery and Chapter 90 included optical Instruments. ITA presently covers 150 products under two lists called Attachment A and Attachment B, and most countries maintain both the lists. While Attachment A is exhaustive and covers IT products, semiconductor manufacturing and equipment testing as well as parts, Attachment B provides for inclusion of additional products outside Attachment A as a positive list, with close product descriptions whenever they are classified under HS in the member countries. This clearly gives rise to confusion and complexity.

Moreover, partial coverage of products under each sub-heading in the original ITA continued to pose considerable challenge in terms of relevance and accounting. ITA participants did not agree in 1996 on the HS classification of a number of products given the nature of the products in terms of multiple use and technology convergence and only partial coverage of consumer items. HS product classification has itself undergone three revisions since then 2002, 2007 and 2012. There has been differentiated impact of harmonisation on three categories of electronics: electronic components, consumer electronics and telecom, and information technology. It appears that number of subheadings under product categories should have come down in HS 2007 classification. In a way HS 2007 offers a more concise structure for classifying ITA items than earlier HS versions (Jürgen Richtering, 2012). Henn and Gnutzmann-Mkrtchyan (2015) suggest that a given tariff line may have covered a lot of ITA products (relative to non-ITA products), when trade was reported

in the HS1996 vintage, and it therefore was considered an ITA product line. However, in later years, this line may not be considered an ITA tariff line any more due to the shift to HS 2007 reporting. The reason is changing trade structure. Now relatively more non-ITA products may be traded under this line as a result of some ITA products having become technologically obsolete.

Portugal-Perez *et al.* (2009) summarise the origin and development of ITA 2 deliberations. Discussions on extension of the ITA, which includes coverage of more electronic products, to non-tariff measures — including standards, began shortly after the ITA was signed in 1996. In 2000, the Committee of Participants on the Expansion of Trade in Information Technology Products (ITA Committee) agreed on its "Non-Tariff Measures Work Programme". This document aimed to identify Non-Tariff Measures (NTMs) which were impediments for trade and to examine the economic and developmental impact of such measures on trade in ITA products. In September 2008 the EU submitted a proposal to review and initiate negotiations to update the ITA. On non-tariff barriers it proposed, "... agreement on substantive provisions concerning the recognition of internationally agreed standards and of methods of conformity assessment, in order to avoid multiple testing and enable greater economies of scale without compromising on product safety".[4]

In June 2012, six ITA participants (United States, European Union, Japan, the Republic of Korea, Chinese Taipei and Costa Rica) initiated an informal process towards launching negotiations for the expansion of the product coverage of the ITA. This process led to the establishment of a technical working group which has been meeting informally in Geneva, outside of the formal framework of the WTO ITA Committee.[5]

Last year following a meeting in May 2015 of the Information Technology Agreement (ITA) Committee there was a palpable urge to conclude the ongoing negotiations on the expansion of the ITA product coverage (ITA 2) soon. The US stressed that ITA 2 is a top priority and EU announced consensus on product coverage. Japan has been keen on extending such provisions to regional trade deals. Norway, Switzerland,

Canada, Chinese Taipei, Montenegro, Singapore, Colombia, Australia and Hong Kong, China also supported the early conclusion of ITA 2. While Korea was close to ratifying such changes, China was firm on its stand of protecting domestic interests even as it saw merit in ITA 2. Deliberations and workshops on NTMs were conducted on a regular basis. The negotiation was strongly focussed on "for each area of certification: one global product, one global standard, one global test and one global certificate."[6]

In the run up to the 10th Ministerial Conference of the WTO in Nairobi, Kenya in December 2015 several key meetings took place. There was a meeting held on 18 July 2015 in which negotiators from 53 WTO members reached a deal to expand the ITA and eliminate tariffs on an additional list of roughly 200 products valued at about USD 1.3 trillion in annual trade. On 24 July 2015, a tentative accord reached by 54 WTO members on 18 July 2015 was confirmed as the basis for implementation work to begin at a meeting at the WTO headquarters in Geneva. Under the terms of the agreement, the majority of tariffs will be eliminated on these products within three years, with reductions beginning in 2016. By the end of October 2015, each of the participating members submitted to other participants a draft schedule which spells out how the terms of the agreement would be met.[7],[8] Accordingly, at the WTO's Tenth Ministerial Conference in Nairobi (16 December 2015) 53 members representing major exporters of information technology products, endorsed the timetable for implementing the landmark deal to eliminate tariffs on the 201 IT products. The declaration established that the first set of tariff cuts (65 per cent of tariff lines) were to be implemented by 1 July 2016 and the second set no later than 1 July 2017, with successive reductions taking place from 1 July 2018 and effective elimination no later than 1 July 2019.[9] On 1 November 2016, WTO's ITA Committee announced majority of participants (18 of the 24, who originally represented the 53 countries under ITA 2) have implemented their tariff commitments, and others were on track to do so.[10]

V. BRICS Trade in Biotech Products (Agriculture)

According to the International Service for the Acquisition of Agri-biotech Applications (ISAAA) of the 28 countries which planted biotech crops in 2014, 20 were developing (including the new biotech crop country Bangladesh) and only 8 were industrial countries. Each of the top 10 countries, of which 8 were developing, grew more than 1 million hectares providing a broad-based worldwide foundation for continued and diversified growth in the future. All BRICS nations except Russia feature in the top 10 lead by Brazil (Table 10).

Table 10: Global Area of Biotech Crops in 2014: by Country (Million Hectares)[**]

Rank	Country	Area(million hectares)	Biotech Crops
1	USA*	73.1	Maize, soybean, cotton, canola, sugarbeet, alfalfa, papaya, squash
2	Brazil*	42.2	Soybean, maize, cotton
4	India*	11.6	Cotton
6	China*	3.9	Cotton, papaya, poplar, tomato, sweet pepper
9	South Africa *	2.7	Maize, soybean, cotton

Notes: * 19 biotech mega-countries growing 50,000 hectares, or more, of biotech crops.

** Rounded off to the nearest hundred thousand.

Source: ISAAA Brief 43-2011 and ISAAA Brief 49-2014 on "Global Status of Commercialized Biotech/GM Crops"

In terms of production, let us take the example of Brazil which is the largest grower of biotech crops among BRICS. The major biotech crops in Brazil are soybeans and maize. The production of soybeans and maize in Brazil were 78.15 megaton (USD 20.08 billion) and 55.66 megaton (USD 2.75 billion), respectively, in 2011. Almost, entire production of maize in Brazil is meant for export (98.67 per cent in 2011); the figure for soybean was 80 per cent. The five lead developing countries in biotech crops are China and India in Asia, Brazil and Argentina in Latin America, and South Africa in Africa. They collectively grew 71.4 million hectares (44 per cent of global).

Modern technology generated by public sector R&D programmes in Brazil is led by the national agency called Brazilian Agricultural Research Corporation (EMBRAPA) with due role of institutions like Federal-funded Sugar and Alcohol Institute (IAA) and Brazilian Institute of Coffee (IBC) Coffee Rio Grande do Sul´s Rice Institute (IRGA) has immensely supported Brazil's emergence as a global leader in Biotech crop production.

VI. Concluding Remarks

Though still very heterogeneous in terms of size of economies and character of economic development, aspirations and scope of industrial development could be similar in BRICS countries. The Newly Industrialised Countries of Asia, though smaller in size with respect to national income and populations, implemented policies that helped them to leverage opportunities of trade and investment across industrial sectors and robustly facilitated integration with global production networks. Except China, however, none of the other BRICS countries are well integrated into the global production networks, let alone in high technology goods.

High technology trade in BRICS has improved with overwhelming contribution from China. With rising per capita incomes, backed by similar levels of technological expertise and cost structure, rapid and simultaneous expansion of high-technology industries in each of these countries is not unlikely. With potential commonalities, BRICS countries could be competing with each other in the world market in select product categories including in high-technology goods. At the same time BRICS offers a large market for these products with ever growing middle class segment. This also suggests substantial scope for intra-regional trade in high technology products within BRICS. Such convergence of economic interests justifies collective action by BRICS in negotiations concerning trade in technology intensive products, and international regulatory frameworks on technology related issues.

The Geneva-based international think-tank, the South Centre, in one of the publications in 2013 has highlighted that Non-tariff barriers (NTBs) – in the form of national standards and regulations or international standards – have been the most significant barriers that developing country products face in accessing the ITA markets, whether or not these countries are part of the ITA. It also highlights that special and differential treatment (S&DT) under the ITA is of very limited scope; there are no exceptions to product coverage, and the agreement only offers extended or gradual elimination of tariffs. These periods do not necessarily allow the needed time for building or advancing an IT sector in developing countries.

Although it is widely accepted that gaining from trade is critically linked to country's economic and production structure, the adverse effect of trade on domestic production and hence development is much less appreciated. While there is a case for strengthening domestic production and capacity building, importance of safeguards is often contested by advanced economies. It has always been the case with advanced economies like the US, the EU, Japan, etc., when they have been collectively successful in pushing through institutional provisions at multilateral agreements that benefitted them on the balance. Therefore, negotiations under ITA runs counter to the spirit of Special and differential treatment as mandated under the WTO.

Even as production and trade in high-technology products offer variety of opportunities in terms of movement along the value chain and increasing technological depth in the manufacturing sector, the sectors definitely require proactive policy support in developing countries. This does not imply inward-looking policies but greater engagement by emerging economies at negotiating platforms to ensure balanced international treaties governing trade in technologies for promoting technological catch-up. The BRICS which has converging economic interests in seeking greater market access for manufactured goods and expanding domestic industrial activity should forge an alliance to influence such treaties.

The share of BRICS economies in trade in HTP has expanded. However, commensurate leveraging of trade architecture on rule making has not happened. Forum like the WTO, where sector specific plurilateral agreements are signed do not reflect the new reality. In the area of trade in biotech products there are serious divergences in the global rule making process and appropriate classification of agricultural produce based on the technology of production. The Cartagena Bio-safety Protocol under the Convention on Biological Diversity (CBD) does not get a chance to make substantive headway on the issue, since progress made in the World Customs Organization (WCO) that is responsible for Harmonised System Classification of traded commodities is not reflected in the modalities pursued by CBD. Moreover, contribution and engagement by BRICS in shaping such architectures like the WCO towards classification of agricultural commodities is inadequate. BRICS should initiate creation of joint platforms where ideas can be exchanged. Finally, collective work among BRICS is needed in order to pursue other areas of international negotiations that have implications for access to HTPs, like in the realm of climate change under the UNFCCC and other forums.

Endnotes

[1] As per the UNCTAD definition of "emerging countries" developing economies are expected to satisfy at least three of the following criteria:

- Steady economic growth over the past decade
- An increase in knowledge-intensive exports, both globally and to other developing countries
- Increasing investments in R&D
- A rise in indicators of progress in science and technology, such as scientific publications and patents, and
- Associated policy and institutional underpinnings that trend to be oriented towards long-term economic development.

[2] See Appendix 2 for more detail.

[3] This may not be surprising. We have already argued that high-technology products carry intellectual assets that generate maximum rents. While agriculture is purely a resource-based production, automobile has been classified broadly under medium tech products.

[4] There are a number of initiatives underway in regional trade and industry groups to harmonise standards in electronic and electrical products (Portugal-Perez *et al*., 2009).

These include: the Association of Southeast Asian Nations (ASEAN), Asia Pacific Economic Cooperation (APEC), Pan American Standards Commission (COPANT), among others.

[5] https://www.wto.org/english/thewto_e/minist_e/mc9_e/brief_ita_e.htm

[6] https://www.wto.org/english/news_e/news15_e/ita_08may15_e.htm

[7] On 28 July 2015, EU Ambassador to the WTO declared in a meeting of the WTO's General Council the joining of China Taipei and Thailand - both large producers of IT products in accepting the deal, which meant tariffs removed on products such as new-generation semi-conductors, GPS navigation systems, tools for manufacturing printed circuits, telecommunications satellites, and touch screens. Nearly all the participants confirmed their acceptance of the product coverage list, which was finalised on 24 July 2015. The Agreement takes effect once participants accounting for approximately 90 per cent of world trade in the covered goods have their draft schedules approved.

[8] https://www.wto.org/english/news_e/news15_e/ita_28jul15_e.htm

[9] *ibid.*

[10] https://www.wto.org/english/news_e/news16_e/ita_01nov16_e.htm

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Appendix 1

Table A1: Top 5 High-Technology Exported Products in 2014 (USD million)

	Brazil				India			
	SITC Code	Description	Quantum	Share in total HTPs	SITC Code	Description	Quantum	Share in total HTPs
1	792	Aircraft/ spacecraft	4049.1	46.68	792	Aircraft/ spacecraft	6720.71	39.94
2	716	Rotating electrical plant	1421.34	16.38	541	Pharmaceuticals Products	2242.9	13.33
3	778	Electrical Equipments	679.85	7.84	764	Telecommunication Equipment	1732.95	10.3
4	541	Pharmaceuticals Products	441.92	5.09	778	Electrical Equipment	1308.35	7.78
5	874	Measure/ control apparatus	416.81	4.8	771	Electric power Equipment	1083.3	6.44
	China				South Africa			
	SITC Code	Description	Quantum	Share in total HTPs	SITC Code	Description	Quantum	Share in total HTPs
1	764	Telecommunication Equipment	227691.5	30.51	764	Telecommunication equipment	686.93	20.99
2	752	Computer Equipment	167542.2	22.45	792	Aircraft/ spacecraft	411.37	12.57
3	776	Valves/ transistors	93412.22	12.52	874	Measure/ control apparatus	378.78	11.58
4	778	Electrical Equipment	54727.34	7.33	778	Electrical Equipment	299.78	9.16
5	759	Office equip parts & Parts	39517.65	5.29	761	Television receivers	258.48	7.9

Source: Authors' calculations based on data obtained from WITS online.

Table A2: Top Ten Export Destinations for High Technology Products of BICS Countries in 2005 and 2014

	Brazil		India	
	2005	2014	2005	2014
1	United States (3636.32, 3.07)	United States (3281.41, 1.46)	United States (667.57, 0.67)	Sri Lanka (2055.62, 0.65)
2	Argentina (1181.88, 1)	Argentina (660.7, 0.29)	Germany (234.77, 0.23)	United States (1992.5, 0.63)
3	Canada (491.19, 0.41)	Mexico (372.44, 0.17)	Singapore (154.87, 0.15)	United Arab Emirates (1839.04, 0.58)
4	Venezuela (447.68, 0.38)	China (312.48, 0.14)	United Arab Emirates (153.15, 0.15)	China (757.6, 0.24)
5	Germany (344.32, 0.29)	Germany (288.41, 0.13)	United Kingdom (141.78, 0.14)	Singapore (683.93, 0.22)
6	Chile (308.43, 0.26)	Netherlands (248.02, 0.11)	Netherlands (124.86, 0.12)	United Kingdom (611.44, 0.19)
7	Colombia (263.14, 0.22)	Ireland (189.38, 0.08)	China (101.93, 0.1)	France (542.22, 0.17)
8	Mexico (221.17, 0.19)	France (186.71, 0.08)	Italy (64.83, 0.06)	Germany (532.39, 0.17)
9	India (182.44, 0.15)	United Kingdom (173.99, 0.08)	France (60.9, 0.06)	Saudi Arabia (423.73, 0.13)
10	Finland (131.83, 0.11)	Belgium (167.47, 0.07)	Turkey (60.03, 0.06)	Turkey (419.93, 0.13)
	China		South Africa	
	2005	2014	2005	2014
1	Hong Kong, China (62805.02, 8.24)	Hong Kong, China (193153.2, 8.25)	India (268.93, 0.57)	Namibia (315.07, 0.35)
2	United States (55354.46, 7.26)	United States (143992.71, 6.15)	United States (163.59, 0.35)	Botswana (240.81, 0.27)
3	Japan (21960.07, 2.88)	Japan (44198.51, 1.89)	Netherlands (149.24, 0.32)	Zambia (220.35, 0.24)
4	Germany (14775, 1.94)	South Korea (40515.95, 1.73)	France (137.43, 0.29)	United Arab Emirates (207.8, 0.23)
5	Netherlands (14055.79, 1.84)	Netherlands (35266.89, 1.51)	United Kingdom (107.93, 0.23)	United States (187.23, 0.21)
6	South Korea (8883.99, 1.17)	Germany (23664.33, 1.01)	Germany (91.44, 0.19)	Mozambique (175.7, 0.19)
7	Singapore (8307.6, 1.09)	Other Asia, nes (20590.88, 0.88)	Nigeria (83.61, 0.18)	United Kingdom (134.16,0.15)
8	Other Asia, nes (6615.14, 0.87)	Singapore (16056.51, 0.69)	Angola (75.88, 0.16)	Zimbabwe (128.8, 0.14)
9	Malaysia (5479.77, 0.72)	India (14804.07, 0.63)	Zimbabwe (57.51, 0.12)	Nigeria (123.46, 0.14)
10	United Kingdom (5117.83, 0.67)	United Kingdom (13950.97, 0.6)	Mozambique (50.74, 0.11)	Germany (120.66,0.13)

Note: Values in parentheses are export value in USD million and percentage share of individual countries' total exports.

Source: Authors' calculations based on data obtained from WITS online.

Table A3: Intra-BRICS Exports of High Technology Products

(Value in USD million)

	Partner Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	CAGR (percent)
Brazil	**China**	94.18	117.66	134.22	342.59	473.25	457.29	760.22	1040.21	454.20	312.48	12.74
	India	182.44	122.14	36.18	81.67	106.21	70.93	57.21	214.52	71.27	86.02	-7.24
	Russian Federation	1.78	9.18	7.05	34.35	2.94	2.73	31.86	6.99	32.21	6.79	14.30
	South Africa	58.94	70.93	100.01	134.27	72.11	72.47	100.82	92.87	98.87	77.52	2.78
	Total	337.33	319.92	277.45	592.87	654.51	603.41	950.11	1354.59	656.55	482.81	3.65
	Partner Country	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**CAGR (percent)**
China	**Brazil**	1646.51	2629.22	3765.52	6013.67	5094.29	7803.69	9378.34	9573.53	9994.23	8837.36	18.30
	India	2617.90	4862.07	8531.70	10409.19	11134.13	13128.90	14688.80	13673.78	14367.62	14804.07	18.92
	Russian Federation	1273.56	2092.95	3481.11	4869.65	2710.83	5682.94	6802.23	7734.11	7687.20	8856.51	21.40
	South Africa	576.81	904.22	1189.86	1613.60	1440.02	2264.62	2473.86	2311.11	3260.01	3032.29	18.05
	Total	6114.78	10488.46	16968.19	22906.11	20379.28	28880.14	33343.23	33292.52	35309.06	35530.24	19.24

Table A3 continued...

Table A3 continued...

India	**Partner Country**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**CAGR (percent)**
	Brazil	38.40	40.59	139.19	262.35	184.81	120.48	175.28	169.56	223.01	209.11	18.47
	China	101.93	107.96	144.60	159.94	336.29	306.95	487.99	394.50	660.36	757.60	22.21
	Russian Federation	29.65	53.81	76.23	127.93	96.23	111.65	323.75	431.26	331.01	199.08	20.98
	South Africa	27.92	42.09	47.90	75.35	199.45	152.25	226.19	245.40	299.73	110.23	14.72
	Total	197.91	244.45	407.91	625.58	816.79	691.34	1213.21	1240.72	1514.10	1276.01	20.49
South Africa	**Partner Country**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**CAGR (percent)**
	Brazil	4.98	8.84	9.79	4.54	4.53	4.66	5.81	7.01	7.72	9.67	6.86
	China	18.24	39.36	25.75	38.65	18.02	25.24	38.52	30.35	16.42	28.33	4.50
	India	268.93	95.04	36.57	27.86	27.35	29.64	41.86	50.59	22.49	49.40	-15.59
	Russian Federation	1.84	0.57	6.74	6.48	4.07	9.02	5.60	18.44	19.10	13.87	22.38
	Total	293.99	143.81	78.85	77.53	53.98	68.56	91.79	106.40	65.73	101.26	-10.11

Source: Authors'calculations based on WITS Database Online.

Table A4: Commodity Specific Grubel-Lloyd Index for China and Brazil

SITC-3	Description	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
716	Rotating electric plant	44.53	42.52	31.97	17.86	18.93	4.83	5.25	13.4	7.96	12.45
771	Electric power transmission equipments	12.93	9.39	7.37	2.53	1.21	0.7	2.46	1.77	8.18	10.57
874	Measure & control apparatus	45.35	45.9	24.35	16.18	11.45	12.41	15.02	10.89	7.5	9
718	Power generating equipments	22.85	7.63	23.57	88.94	77.75	37.6	38.27	9.4	6.22	7.61
778	Electrical equipment	14.15	12.04	9.05	5.44	5.3	3.48	4.15	4.51	4.09	6.08
541	Pharmaceutical products	0.05	0.31	0.02	0.54	0.51	0.59	4.22	4.4	3.2	4.66
792	Aircraft/spacecraft	19.28	8.67	14.26	0	0.01	0.33	0.02	0.08	0.31	2.28
776	Valves/transistors	26.58	17.59	4.44	13.13	4.27	4.48	4.54	5	2.96	0.65
752	Computer equipment	0.12	0.04	0.03	0.02	0.26	0.04	0.04	1.14	0.62	0.6
764	Telecommunication equipment	2.91	2.84	1.07	0.79	1.7	0.88	0.91	1.64	0.91	0.49
759	Office equipment	1.25	1.12	0.4	0.13	0.63	0.43	0.18	0.29	0.42	0.17
524	Other inorganic chemical	0.83	0.01	0.48	0.07	18.52	0.75	0	0.51	0.06	0.06
761	Television receivers	0.32	0.01	0.51	0.3	0.02	0.03	0.01	0.01	0.01	0.05
774	Medical electro diagnostic equipment	0.74	0.12	0.31	0.03	0.01	0.01	0	0.01	0.07	0.05
871	Optical instruments	3.59	2.24	0	0	0.01	0.02	0.02	0.14	0.1	0.02
712	Steam/vapour turbines		0	0	0	0	0	0	0	0	0
751	Office machines	0.31	1.92	0.01	0	0	0.27	0.08	0	0	0
881	Photographic equipment	0.02	4.17	35.39	0	0	0	0	0	1.35	0

Note: Values are in percentage.

Source: Authors' calculation.

Table A5: Commodity Specific Grubel-Lloyd Index for China and India

SITC-3	Description	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
774	Medical electro diagnostic equipment	70.01	81.5	97.14	92.83	85.24	70.61	61.21	67.32	65.14	76.37
718	Power generating equipments	89.33	64	44.2	29.19	54.02	19.19	19.72	20.63	30.39	28.53
771	Electric power transmission equipments	41.17	28.02	14.43	14.77	12.06	14.73	14.35	13.23	14.03	22.84
874	Measure/control app	39.31	26.79	21.43	18.13	17.2	27.47	23.96	18.99	17.43	22.84
716	Rotating electric plant	18.8	13.24	18.11	12.25	12.94	14.59	8.34	12.21	13.5	16.49
759	Office equipment and parts	11.15	27.82	28.24	10.62	8.2	7.74	10.7	10.5	10.01	10.56
541	Pharmaceutical products	33.56	16.09	14.42	13.7	10.26	11.13	12.22	11.68	8.16	8.41
776	Valves/transistors	48.94	32.61	25.44	31.27	21.09	30.52	10.73	15.04	8.9	7.29
778	Electrical equipment	10.67	6.29	5.96	4.78	4.56	5.59	6.29	4.82	6.51	6.02
764	Telecommunication equipment	0.24	0.43	0.69	0.6	1.7	6.46	6.64	4.31	3.54	4.36
881	Photographic equipment	3.83	7.71	3.46	2.51	4.5	6.02	3.24	1.83	2.12	4.09
712	Steam/vapour turbines	0	0	0.8	0	0	0	0	0	0.17	1.51
524	Other inorganic chemical	0.35	0.28	1.09	0.38	0.74	2.73	13.42	5.89	0.34	1.23
792	Aircraft/spacecraft	0	0.47	10.99	29.64	0.03	0.65	21.2	81.29	51.29	0.83
761	Television receivers	0.18	0.86	0.06	0.01	0.01	0.06	0.03	0.39	1.31	0.42
752	Computer equipment	0.86	0.54	0.33	0.17	0.22	0.21	0.21	0.4	0.4	0.2
751	Office machines	0.01	0.85	1.67	0.09	0.15	0.57	0.12	0.18	0.09	0.18
871	Optical instruments	22.2	7.37	5.51	5.78	1.03	0.1	0.09	0.17	0.21	0.16

Note: Values are in percentage.

Source: Authors' calculation.

Table A6: Commodity Specific Grubel-Lloyd Index for China and South Africa

SITC-3	Description	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
524	Other inorganic chemical	33.23	51.44	55.17	11.27	1.89	1.24	68.39	67.24	0.02	95.36
792	Aircraft/spacecraft	1.12	8.62	85.85	37.74	0.37	2.04	13.48	39.01	49.21	24.82
874	Measure & control apparatus	23.05	20.8	14.99	26.93	53.14	56.15	25.14	12.95	22.84	21.57
712	Steam/vapour turbines		0	0	0	0	0	0	0	0	20.65
541	Pharmaceutical products	9.46	8.87	12.63	11.32	13.23	8.97	20.36	17.25	13.74	15.45
776	Valves/transistors	5.4	41.85	12.71	9.33	3.64	4.97	9.66	10.28	0.96	2.79
774	Medical electro diagnostic equipment	2.82	0.77	0	0.02	0.03	7.74	0.02	0.01	0.06	1.18
759	Office equipment and parts	0.63	0.39	2.53	0.93	1.91	0.46	0.58	0.59	0.39	0.75
778	Electrical equipment	1.97	1.17	0.51	8.48	2.72	1.52	4.86	2.61	1.61	0.57
771	Electric power transmission equipments	1.4	0.07	0.23	0.34	0.53	0.35	1.81	3.67	0.95	0.39
718	Power generating equipments	27.92	75.22	2.51	2.41	10.07	1.15	35.23	0.28	0.28	0.38
764	Telecommunication equipment	1.31	1.03	0.35	0.41	0.19	0.38	0.68	0.22	0.3	0.28
752	Computer equipment	0.47	0.12	0.11	0.45	0.06	0.15	0.02	0.08	0.03	0.05
716	Rotating electric plant	0.1	2.71	0.47	2.76	0.9	1.6	0.06	0.49	0.37	0.03
871	Optical instruments	0.13	80.79	0.04	0.16	0.85	0.43	0.26	0.07	0.03	0.01
751	Office machines	0.12	0.01	0	0.09	0.04	0.05	0.06	0	0.03	0
761	Television receivers	0	0	0	0	0.01	0.07	0	0	0	0
881	Photographic equipment	0	0.31	0	0	0	6.08	0	0	0	0

Note: Values are in percentage.

Source: Based on authors' calculation.

Table A7: Commodity Specific Grubel-Lloyd Index for China and Russia

SITC-3	Description	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
718	Power generating equipments	0.91	3.06	11.51	27.45	22.92	42.25	81.08	87.19	79.91	38.23
871	Optical instruments	22.47	4.39	6.2	2.8	3.16	7.43	10.37	20.62	20.63	32.46
874	Measure & control apparatus	63.78	34.6	30.56	32.96	59.51	29.23	30.23	30.79	25.28	28.14
524	Other inorganic chemical	97.78	56.07	37.69	26.88	44.85	53.61	82.29	93.37	98.55	23.03
776	Valves/transistors	53.32	71.36	67.47	75.05	99.37	66.61	51.02	33.59	28.45	18.58
712	Steam/vapour turbine	0	0	0	28.69	5.16	9.25	6.61	7.94	2.87	16.86
774	Medical electro diagnostic equipment	12.81	15.23	12.8	32.93	12.89	9.17	5.15	8.34	6.12	13.91
792	Aircraft/spacecraft	3.85	33.14	48.7	9.47	4.71	7.7	31.61	13.69	19.48	9.21
771	Electric power transmission equipments	0.93	0.52	0.31	0.28	1.36	3	2.26	2.56	1.3	2.53
716	Rotating electric plant	21.88	10.44	5.55	1.82	5.35	0.78	2.2	4.15	2.21	1.55
778	Electrical equipment	6.83	2.76	1.52	1.23	1.73	1.04	1.28	1.86	1.59	1.05
881	Photographic equipment	36	75.25	0.01	0.1	0	0	0	1.24	0.87	0.95
751	Office machines	1.2	0.33	1.25	0.42	1.85	0.4	0.22	0.23	0.33	0.14
764	Telecommunication equipment	1.22	0.23	0.06	0.11	0.28	0.07	0.3	0.18	0.55	0.13
541	Pharmaceutical products	0.45	0	0.01	0.1	0.44	0	0	0	0	0.02
752	Computer equipment	0.07	0.14	0.09	0.12	0.05	0.04	0.01	0.05	0.05	0.02
759	Office equipment and parts	0.07	0	0.17	0.08	0.06	0.02	0.02	0.01	0.02	0
761	Television receivers	0	0	0	0	0	0	0	0.13	0.04	0

Note: Values are in percentage.

Source: Authors' calculation.

Table A8: Commodity Specific Grubel-Lloyd Index for India and China

SITC-3	Description	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
774	Medical electro diagnostic equipment	86.47	78.8	76.44	66.17	73.5	69.73	60.53	61	66.11	61.41
716	Rotating electric plant	5.66	13.23	8.58	7.32	31.4	10.99	13.15	14.08	15.85	16.95
874	Measure & control apparatus	27.9	18.29	15.26	11.74	13.13	10.32	9.01	9.13	12.33	16.04
771	Electric power transmission equipments	21.34	17.36	4.82	5.87	7.41	10.09	9.05	9.59	10.77	15.33
718	Power generating equipments	20.72	19.19	64.48	8.8	5.66	13.03	10.23	10.94	8.19	13.08
541	Pharmaceutical products	21.02	11.23	10.77	13.08	11.61	10.76	14.8	11.42	9.5	10.01
759	Office equipment and parts	2.18	2.66	2.98	5.75	7.01	5.72	10.01	10.19	8.91	7.74
881	Photographic equipment	1.62	13.03	4.28	9.74	8.12	4	13.45	2.87	3.35	5.3
792	Aircraft/spacecraft	0	38.62	31.33	13.47	98.5	90.69	50.48	28.76	8.67	4.84
778	Electrical equipment	6.1	3.99	2.95	3.28	5.52	4.14	5.87	2.42	3.85	4.82
776	Valves/transistors	7.07	5.6	10.96	5.73	6.12	10	4.71	2.24	2.63	2.74
764	Telecommunication equipment	0.49	0.8	0.77	0.82	3.4	1.98	4.03	2.91	2.55	2.03
712	Steam/vapour turbines	0.14	1.23	0.52	3.89	0.01	15.72	1.57	7.97	0.65	1.6
761	Television receivers	0.33	0.42	0.01	0.05	6.39	0.06	0.07	0.01	1.05	1.03
524	Other inorganic chemical	2.17	0.77	1.01	0.14	0.08	3.45	13.17	1.38	0.22	0.94
871	Optical instruments	38.33	34	20.78	22.43	13.16	0.24	1.44	0.16	0.35	0.43
752	Computer equipment	1.53	1.26	0.33	0.37	1.17	0.2	0.63	0.79	0.69	0.19
751	Office machines	14.21	17.34	47.26	18.84	0.35	0.23	0.37	0.17	0.16	0.17

Note: Values are in percentage.

Source: Authors' calculation.

Table A9: Commodity Specific Grubel-Lloyd Index for India and Brazil

SITC-3	Description	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
778	Electrical equipment	72.18	57.44	75.04	67.53	82.86	64.11	32.51	51.86	62.44	85.73
752	Computer equipment	94.16	76.63	0.75	0.15	7.2	4.81	27.37	72.15	87.68	78.76
774	Medical electro diagnostic equipment	34.24	29.56	9.78	45.44	25.02	25.04	52.25	16.72	35.11	74.08
524	Other inorganic chemical	59.48	39.55	27.67	2.02	1.96	12.46	36.9	19.82	56.77	74.04
759	Office equipment and parts	50.95	60.7	15.28	70.86	95.09	58.78	44.25	23.19	45.7	74.03
874	Measure & control apparatus	84.58	76.06	91.49	91.99	55.72	91.38	84.81	88.8	39.9	63.95
751	Office machines	11.85	0	30.02	59.45	65.99	61.05	47.56	64.65	95.53	62.71
771	Electric power transmission equipments	46.95	15.71	8.78	13.2	3.99	64.44	11.6	37.87	14.85	50.69
761	Television receivers	0	0	0	9.9	21.89	77.73	15.24	3.39	0	49.11
764	Telecommunication equipment	8.7	11.95	71.86	68.66	88.01	64.23	99.74	66.95	24.18	46.59
776	Valves/transistors	20.26	36.41	60.95	91.19	60.05	40.54	78.83	52.83	52.91	46.15
712	Steam/vapour turbines	0	26.38	0	0.62	3.66	0	13.97	0	0	43.59
716	Rotating electric plant	15.5	14.56	23.38	11.35	15.67	28.94	24.87	25.56	15	29.71
718	Power generating equipments	6.18	0	88.31	23.6	29.44	10.69	25.35	56.48	2.18	13.15
541	Pharmaceutical products	2.19	3.11	8.16	4.88	3.69	10.24	23.69	20.02	16.79	7.33
881	Photographic equipment	0	0	15.73	83.28	0	0	89.32	76.54	9.88	0.94
792	Aircraft/spacecraft	0	0	8.04	0	1.89	19.54	43.84	0.05	0.46	0.02
871	Optical instruments	77.29	91.3	0	78.14	7.75	70.56	3.88	72.77	38.05	0

Note: Values are in percentage.

Source: Authors' calculation.

Table A10: Commodity Specific Grubel-Lloyd Index for India and South Africa

SITC-3	Description	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
759	Office equipment and parts	71.6	84.92	13.14	21.87	61.37	96.33	58.72	70.94	74.46	95.62
761	Television receivers	14.09	0	0	0	68.55	8.72	0.97	6.72	41.24	84.96
874	Measure & control apparatus	67.28	30.68	28.63	18.53	29.16	33.5	30.27	18.99	12.21	51.04
764	Telecommunication equipment	14.46	83.17	69.37	78.35	8.47	11.08	28.27	7.48	2.32	33.66
712	Steam/vapour turbines	0	0	0	0	0	0	0.17	0	35.35	26.11
778	Electrical equipment	43.69	47.21	31.39	87.93	11.69	8.76	8.59	12.05	26.52	25.79
881	Photographic equipment	10.13	98.33	0	31.06	82.81	0	63.27	53.99	0	21.85
541	Pharmaceutical products	34.5	42.21	39.42	24.72	34.18	14.89	26.37	46.12	26.33	19.15
524	Other inorganic chemical	18.21	1.04	3.23	9.79	3.18	6.56	14.94	20.35	9.93	12.51
792	Aircraft/spacecraft	41.63	14.7	18.85	21.93	24.92	11.01	48.01	10.94	9.59	7.04
774	Medical electro diagnostic equipment	55.4	11.58	0	10.74	9.22	98.22	65.91	75.51	24.74	6.73
752	Computer equipment	49.98	71.1	11.03	6.14	8.02	35.83	36.65	52.15	14.7	4.43
718	Power generating equipments	24.03	4.04	10.4	11.86	73.65	64.53	74.21	60.56	0.33	4.08
751	Office machines	8.91	0	0	0	0.02	12.02	73.47	43.24	1.31	3.04
716	Rotating electric plant	7.95	39.89	27.81	88.44	1.2	28.46	8.43	8.06	0.06	2.18
776	Valves/transistors	71.04	86.85	29.18	92.39	13.86	21.32	0.83	5.29	0.7	2.09
771	Electric power transmission equipments	16.86	2.58	0.32	8.98	22.64	33.99	16.33	2.1	0.5	0.78
871	Optical instruments	29.74	39	57.86	42.45	97.33	20.79	86.33	0.17	14.96	0

Note: Values are in percentage.

Source: Authors' calculation.

Table A11: Commodity Specific Grubel-Lloyd Index for India and Russia

SITC-3	Description	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
776	Valves/transistors/etc	41.13	19.76	26.35	28.02	95.06	81.38	20.8	78.22	81.19	79.13
716	Rotating electric plant	6.84	10.29	95.04	51.03	85.12	68.98	45.52	66.69	84.81	75.83
752	Computer equipment	9.86	82.87	5.29	76.8	6.96	8.83	30.93	5.52	38.77	66.41
774	Medical electro diagnostic equipment	72.24	2.82	93.75	0.66	38.9	9.44	28.03	95.68	94.39	60.04
764	Telecommunication equipment	83.45	22.47	22.59	37.89	66.22	10.02	6.53	16.99	12.77	57.96
874	Measure & control apparatus	12.35	88.06	10.44	39.73	57.3	58.48	39.65	48.07	76.64	53.56
792	Aircraft/spacecraft	70.76	77.11	68.71	40.41	71.84	53.95	11.41	51.11	48.19	40.93
771	Electric power transmission equipments	62.65	47.25	63.01	50.98	31.16	90.78	37.57	98.03	97.86	31.32
778	Electrical equipment	67.1	68.42	47.96	46.79	80.23	46.66	30.58	39.65	35.31	22.17
718	Power generating equipments	0.74	1.07	3.56	0	0	61.35	3.14	31.24	3.87	12.18
881	Photographic equipment	0	86.23	34.54	0	0.49	0	60.77	71.2	78.2	8.89
524	Other inorganic chemical	82.8	50.74	0	0	0.23	3.26	9.05	13.59	10.27	5.1
759	Office equipment and parts	27	22.65	36.49	95.23	85.18	90.76	82.29	20.74	96.87	3.6
541	Pharmaceutical products	82.12	58.5	41.78	90.68	63.19	14	97.19	53.29	8.28	3.18
712	Steam/vapour turbines	1.81	90.09	0	0	0	0	20.79	0	0	1.82
751	Office machines	8.59	7.25	0.38	21.95	17.58	60.4	64.97	39.78	8.31	1.14
871	Optical instruments	3.4	18.58	0.74	4.44	3	1.67	0.68	0.84	73.77	0.45
761	Television receivers	82.98	35.69	0			0	0	0.21	0	0.18

Note: Values are in percentage.

Source: Authors' calculation.

Appendix 2

Grubel - Lloyd (GL) index

Empirically, intra-industry trade (IIT) is a simultaneous movement of goods in the same industry. A widely used measure of IIT is the Grubel - Lloyd (GL) index. To measure the extent of IIT among BRICS countries in the HTPs, we have calculated commodity-wise GL index from 2005 to 2014. To facilitate comparisons of these measures for different countries over the period of ten years, it is useful to express them as a percentage. The GL index is defined as

$$GL_{ij} = \{(X_{ij} + M_{ij}) - |X_{ij} - M_{ij}|\} / (X_{ij} + M_{ij}) * 100 \quad \text{--------} \quad (1)$$

Where GL_{ij} is the degree of intra-industry trade for country j in product i, X_{ij} is the export of commodity i of country j and M_{ij} *is* the import of commodity i of country j.

The value of GL index ranges between 0 and 100. The GL index assigns pure intra-industry trade, a value of 100 and pure inter-industry trade a value of 0. When the exports of one country are exactly equal to imports of another country in a particular commodity, index is 100. When there are exports but no imports, or vice-versa, measure is 0, which is desirable for trade.

To calculate the average level of IIT for a country j we can rewrite (1) as a weighted average of the GL_j's as

$$GL_j = \sum\{(X_{ij} + M_{ij}) - \sum|X_{ij} - M_{ij}|\} / \sum (X_{ij} + M_{ij}) * 100 \quad \text{------} \quad (2)$$

Where the summation in (2) is over commodity i.

Generally, the GL index has some constraints. GL index is subject to bias mainly due to two reasons. One is due to categorical (commodity) aggregation and secondly is trade imbalance. The aggregation bias occurs because the data aggregates across commodities which are not 'similar' and leads to upward biasness. Whereas the trade imbalance bias occurs when one or the other country has an excessive trade surplus (deficit) and this tends to bias the index downwards. A high trade balance surplus (deficit) is reflected in the second term in the numerator of (2): the higher this term, the lower is GL_j. At last, another downside of the Grubel-Lloyd index is that it does not recognise the direction of trade.

Source: Grubel and Lloyd (1975).

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