Is Intra-Industry Trade Gainful?
Evidence from Manufacturing Industries of India

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Abstract

This paper identifies the increasingly dominant role of *intra*-industry trade (IIT) in India's total merchandise trade at different disaggregated levels of data during the post liberalization era (1990 – 2013) and explores the industry specific hypothesis to explain such trade. In an attempt to look into what forms the majority of India's IIT, we use *unit value dispersion* criterion at HS- 6 digit level to disentangle total IIT into *horizontal* [technologically similar products] and *vertical* [both technologically superior (high vertical) and inferior (low vertical) products] IIT for major six Indian manufacturing industries catering to high magnitude of such trade. We find that technologically inferior quality products (*low vertical* IIT) have been *dominant* over the years in India's export basket reflecting *deterioration* in the terms of trade. Further, in order to examine whether India's overall IIT [in technologically *similar* or *differentiated* ranges of product technology] adheres to the comparative advantage hypothesis, we compute revealed comparative advantage (RCA) for each commodity group engaged in such trade for the selected manufacturing industries. We find that across all forms of IIT, the share of RCA has been low but has improved over the years. Given this observation, we explore econometrically as to what determines the magnitude of total IIT along with its various forms for the select industries. Indicating scale economies and catering for consumer's preference diversity we find that the share of products engaged in trade positively influence the magnitude of said forms of trade. It is also found that it is the increase in the industry's imports that improve the share of (low and high) vertical and horizontal IIT in industry's total trade. In the case of protectionism, we find that anti-dumping initiations made by foreign countries on Indian industries' export of superior technological products lead to quality reversals whereby the foreign country becomes the quality leader. The magnitude of total and low vertical IIT have positively benefited as both the number of products as well as the share of products having a RCA in these forms improve. For high vertical IIT, we find that even though the number of products with RCA positively influences its magnitude, its low share dampens the same. On the other hand, the magnitude of horizontal IIT is negatively influenced by the low number of commodities having RCA. The findings have vital policy implications for trade and strengthening competitiveness of Indian industries.

Keywords: Vertical & Horizontal IIT, Terms of Trade, Revealed Comparative Advantage, Indian Manufacturing Industries.

JEL Classification Codes: C43, F14, L60

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1. Introduction

Prior to 1990s, stringent (as well as orthodox) protectionist trade policies (such as, high import tariffs, binding quota restrictions) had eventually turned India into a moribund state such that India was virtually looked down upon being an isolated (almost closed) economy suffering from prolonged balance of payments crisis. With much desperation and political oppositions, eventually the New Trade Policy in 1991 allowed India to break away from the clutches of such restrictive trade policies and integrate gradually with the world economy. The much awaited bold steps of reforms through the structural adjustment programmes initially resulted in India's growth rate in (total) trade to increase from slightly over 20% to 32% in 1995 before falling again due to the sluggish world trade and falling exports, primarily because of anti-dumping and countervailing measures adopted by the industrialised countries; Stiglitz (2000). Even then India's total trade kept on increasing steadily from Rs. 75,751 crores in 1991 to Rs. 3,74,797 crores by the end of the year 2000. Again, during the first decade of 21st century India's trade got almost *doubled* by 2008, before the fall out due to the global financial meltdown.[1] Even when compared to the growth in world merchandise trade, India's trade grew at a higher rate; see, Fig. 1. However, it is not denying the fact that, even though the large scale economic reforms helped India to get entangled with the world economy but still she remains a paltry player in the world market; see, Fig. 2.[2]

Empirical evidences from across the world indicate that the process of trade liberalization not only drive growth of *inter*-industry trade but also allows countries to specialize in different varieties of the same product and thus supplement growth of *intra*-industry trade (IIT).[3] It is argued that, for inter-industry trade liberalization process allows reallocation of productive resources from import competing industries to those industries in the domestic country that have the comparative cost advantage; see, Caves *et al*. (2009) for a detailed theoretical discussion. While in the context of IIT, it is more likely that reallocation of resources takes place from inefficient to efficient product lines *within* an industry; see, Caves (1981), Hamilton & Kniest (1991), Globerman (1992), and Melitz (2003), among others for similar arguments.

Theoretical models of IIT are classified in two parts: two-way trade in horizontally (different varieties of *similar* technologies or qualities) and vertically (different varieties of *different* technologies or qualities) differentiated goods [H-IIT/ V-IIT]. The first kind follows from the contribution of Krugman (1979, 1980), Lancaster (1979), Helpman (1981), Eaton & Kierzkowski (1984), among others, where product differentiation, and/or scale economies and consumer preferences for product diversity have been modeled. On the other hands, models of IIT in goods of different technologies resort to differences in relative factor intensities which are driven by comparative cost advantage between two trading partners; see, Falvey (1981), Falvey & Kierzkowski (1987), Flam & Helpman (1987), among others. Collectively, models of Vertical IIT demonstrate that a relatively capital and labour abundant country would export a *high* and *low* quality version of the same product (*h*-VIIT/ *l*-VIIT) in which the countries have comparative cost advantage, respectively.

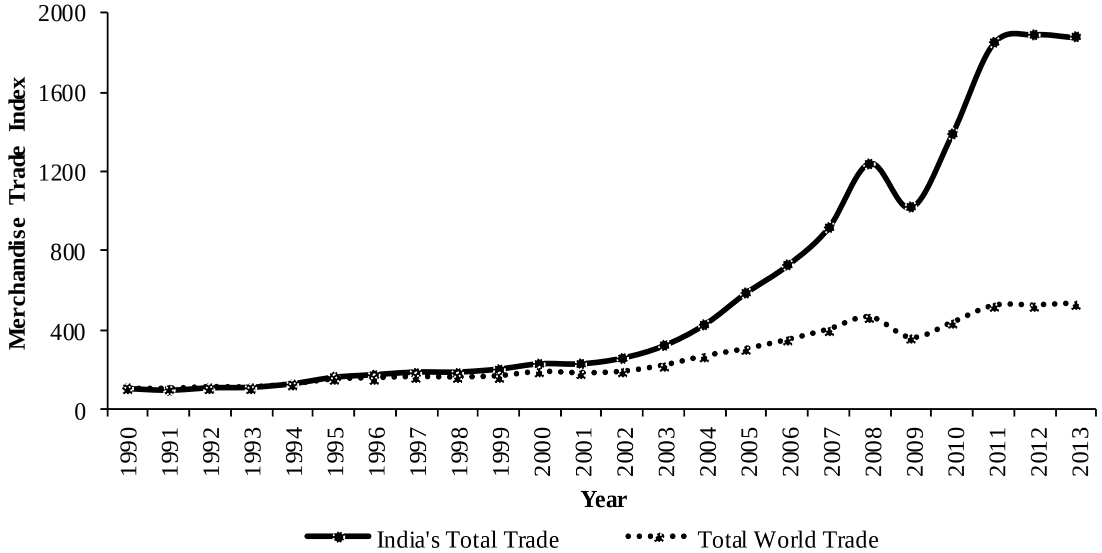

Fig. 1: Total Merchandise Trade Value Index: India vis-à-vis World
Data Source: WTO Statistical Database on International Trade

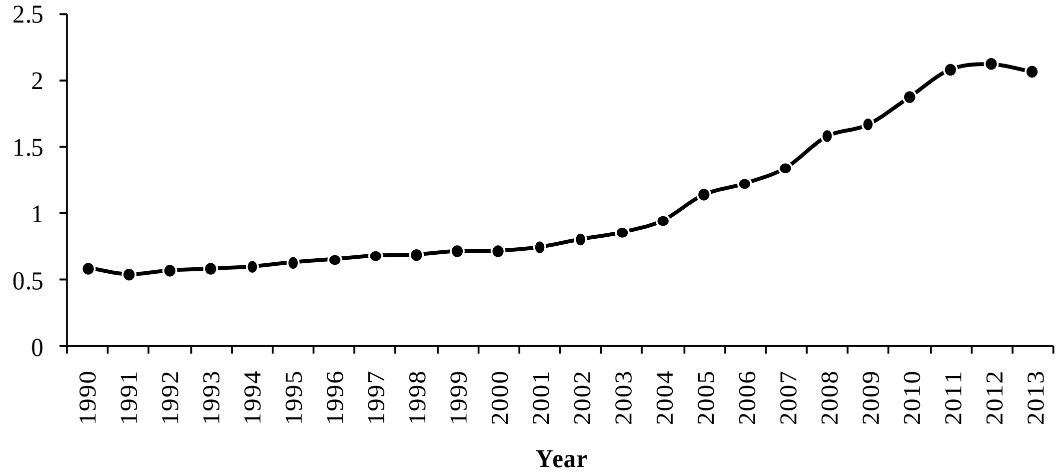

Fig. 2: India's Share of Merchandise Trade in World Trade
Data Source: WTO Statistical Database on International Trade

In the context of India's *intra*-industry trade, Bhattacharyya (1991) finds even before the deliberation of economic reforms in the country there is a rising trend of such trade at the SITC- 2 & 3 digit level

(1970-87).[4] Furthermore, without considering the price of exports and imports of the goods exchanged under IIT Bhattacharyya (1991) postulate that India mostly trades in technologically different products[i.e., vertically differentiated goods] where it imports *higher* technological products from the advanced economies and exports relatively *lower* technological products to the economies that are technologically less advanced than her. Having witnessed a decade of economic reforms, Veeramani (2002, 2004) finds a rise in the magnitude of IIT at the Harmonized System (HS)- 4 digit level in 1990s. Veeramani (2002, 2004) argues that the liberalization process in the country had led to reallocation of productive resources from inefficient to efficient product lines within an Indian firm which in turn hastened intra-industry trade.[5] Besides providing an explanation to the growth of IIT, the study recommends that Indian trade policies needs to be designed in tandem with firms attempt to specialize in narrow product lines. In other words, the country's trade strategies should strive to achieve comparative cost advantage in product lines where firm specializes. Burange & Chaddha (2008) also invokes that the liberalized atmosphere allowed industries to expand their production capacities and thus growth of IIT at the HS- 4 digit level in the period between 1987- 2005. Veeramani (2009) finds again that in a liberalized environment where trade barriers are reduced, Indian firms adapt by specializing in unique varieties of products within an industry which in due course improve the magnitude of IIT.

Given this premise, the main theme of this paper is to undertake a product level analysis so as to identify whether it is IIT in *horizontal* (similar technologies) and *vertical* (both high and low technologies) differentiated products. This led us to examine whether the liberalization process has been able to reallocate productive resources to efficient product lines within an Indian firm or, to put it succinctly, the empirical verification of the comparative advantage hypothesis. This paper contributes to the existing empirical literature in four distinct ways. *Firstly*, improving from the previous literature on India's IIT in its data construction and computation technique, we calculate the magnitude of IIT by considering a variety of (alternative) indices —*static* as well as *dynamic* and more distinctly at various levels of data disaggregation— namely, HS – 2, 4 & 6 digit classification level over the period 1990-2013.[6] Couple of issues draw us to this exercise: (i) we find several alternative indices have been developed over the years for measurement of IIT and most of these indices use different definitions to counter the problem of 'trade imbalances' —*industry* level vis-à-vis at the *country* level. Thus, it is argued that no specific index becomes a preferred choice for the measurement of IIT; see, Tharakan (1984) and Bhattacharyya (1991); (ii) considering different disaggregation levels of data allow us to conduct the 'categorical aggregation' test. This examines whether the trend in magnitude of IIT is consistent at various levels of data disaggregation or as Finger (1975) famously describe measurement of IIT to be just a mere 'statistical artefact'. *Secondly*, having considered the trends and patterns of India's IIT we take individually each of 21 broad commodity sections as classified by the India Trade Classification to identify which among them have the characteristic of such trade at across the said HS classification levels. *Thirdly*, following Greenaway *et al*. (1994) we use 'unit value dispersion criterion' to disentangle total IIT into technologically similar products [i.e., horizontal (H-IIT)] and products of different technologies [i.e., vertical (V-IIT)] & further V-IIT into technologically inferior products [i.e., *l*-VIIT] and technologically superior products [i.e., *h*-VIIT] at the HS- 6 digit level for the industries that cater to such trade. This lead us to examine the gains from such trade using the revealed comparative advantage (RCA) at the HS-6 digit level for the commodity groups engaged in IIT in the select manufacturing industries. *Lastly*, controlling for the possible problem of panel unit root in presence of the cross-sectional dependence we econometrically examine industry specific determinants of the magnitude of total, (low and high) vertical and horizontal IIT.

The reminder of the paper is organized as follows. Section 2 briefly discusses the indices used in this paper for the measurement of IIT and the unit value dispersion criterion to categorize IIT into its different forms. Section 3 delves into analysing the trends and patterns of India's IIT, identifies which industries cater more to IIT and finds out the extent of various forms of IIT along with RCA. Section 4 discusses the data and variables, estimation method and the econometric results. Finally, Section 5 summarizes the paper.

2. Measurement of Intra-Industry Trade

In order to inhibit any kind of opinion on the choice of index for the measurement of the magnitude of IIT we consider indices developed by Michaely (1962) [MH_{ij}], Balassa (1966) [B_{ij}], Grubel & Lloyd (1971, 1975) [GL_{ij}, GLC_{ij}], Aquino (1978) [AQ_{ij}], Vona (1991) [VN_{ij}] and Brullhart (1994) [$MIIT_{ij}$]. See, Table A1 in the appendix for the definition of the indices. To begin with, Balassa's (1966) index considers the ratio of net trade to total trade to arrive at the degree of trade overlap (i.e., simultaneous export and import of a good). While considering all industries that measures country level IIT the author gives equal weights to each of the commodity group or industry irrespective of the particular industry's share in total trade. Subsequently, within few years Grubel & Lloyd (1971) developed a measure that calculates the magnitude of intra-industry trade in total trade. The other advantage of the latter's index over the former is that it accounts for the i^{th} industry's share in total trade of country *j*. Thereupon, Grubel & Lloyd (1975) observed that their previous index will always have a *downward* bias as in practice one cannot find balanced trade. In a rectification, the authors divide their previous index with the ratio of country's overall trade imbalance to total trade. Aquino (1978) argues that since all industries do not have *equi*-proportional trade imbalances, adjustment made by Grubel & Lloyd (1975) must be at industry level rather and not at the aggregate level.[7] The author corrects it by estimating export and import value of each commodity group/industry such that the total exports equal the total imports for the country.[8] Vona (1991) develops its index on the idea that the existence of intra-industry trade is justified at the most disaggregated level of data, irrespective of whether trade is balanced or imbalanced. The author argues that $IIT^{i}_{A,B}$ measures the volume of trade between the trading countries at a higher digit level of data disaggregation. Brullhart (1994) builds a dynamic index that measures the magnitude of IIT in *new* trade flows over two point of time for a country *j*.

2.1. Methods to Disentangle Intra-Industry Trade Into Various Forms

Following the extant empirical literature pioneered by Greenaway *et* al. (1994), we use the ratio of unit value of exports to the unit value of imports, to disentangle total IIT into trade of similar technological products [i.e., horizontal IIT] and trade of different technological products [i.e., vertical IIT] of the same *i*th product.

$$\text{Same Technology or Horrizontal IIT} = \frac{\text{Unit Value of Exports for Good } i}{\text{Unit Value of Imports for Good } i} \in [1-\alpha, 1+\alpha]$$

$$\text{Different Techology or Vertical IIT} = \frac{\text{Unit Value of Exports for Good } i}{\text{Unit Value of Imports for Good } i} \in [1+\alpha, +\infty] \text{ and } [0, 1-\alpha]$$

where α is the dispersion criterion which is usually taken in literatures anything between 10% to 35%.[9] Furthermore, in considering different technology of the same *i*th product, Azhar and Elliott (2006) points out that an *exported* product is considered to be of a *high* technology and *low* technology IIT when the ratio lies between $[1+\alpha,+\infty]$ and $[0,1-\alpha]$, respectively.[10] Thus, in disentangling total IIT for the *i*th product, we have the following identities: $IIT_i = H\text{-}IIT_i + V\text{-}IIT_i$ and $V\text{-}IIT_i = l\text{-}VIIT_i + h\text{-}VIIT_i$.

3. Intra-Industry Trade in India

This section illustrates the experience of intra-industry trade with reference to India over the period 1990-2013. For this, we use India's merchandise trade data against the world from the United Nations Comtrade database at the HS- 2, 4 and 6 digit classification levels. It has two broad sections covering results of India's magnitude of IIT, identifying manufacturing industries of India catering to such trade and finally the share of different forms of IIT along with RCA in the selected manufacturing industries.

3.1. Trends and Patterns of Intra-Industry Trade in India's Merchandise Trade

Looking at Table 1, one finds that across all HS classification levels with fluctuations there has largely been a positive trend in the growth of IIT.[11] Even when we plot the dynamic index $MIIT_{ij}$ we find that there is an upward trend in the share of IIT in new trade flows across all HS classification levels; see, Fig. 3. These results point out that trend in India's magnitude of IIT is consistent at all classification levels and not just a mere statistical artefact.

Both static and dynamic indices reveal that period of 2002-2007 has witnessed a high magnitude of IIT across all the HS classification levels. When compared to the periods of 1990-95 and1996-01, $MIIT_{ij}$ during the period 2008-13 had depicted high percentage of IIT in new trade flows but it fell from the 2002-07 level. We also find that with a higher level of data disaggregation, there is a fall in the magnitude of IIT for both static and dynamic indices. This happens because with a higher classification level, not all commodity groups that join in have simultaneous exports and imports and thus bring the value of index down. Another important observation that we find is that compared to a low level of data disaggregation variance is small for a high level of data disaggregation. This is because at an aggregated level trade values do not contain the necessary information for an IIT analysis – the classic case of an 'aggregation problem'; see, Finger (1975). Following Aquino (1978), we verify whether GL_{ij} & GLC_{ij} are *under* & *over* biased, respectively. We find that across all HS classification levels, GLC_{ij} to be over biased. However, GL_{ij} is under biased at HS- 2 & 6 digit classification levels only. For GL_{ij} the size of the bias falls as one move to a higher classification level whereas for GLC_{ij} size of bias is similar for HS- 4 & 6 digit classification levels. More importantly, unlike Aquino (1978) the size of bias obtained by us is relatively small and thus possesses no serious problem in using GL_{ij} or GLC_{ij}.[12] On the other hand, we find an equivalence of MH_{ij} and AQ_{ij} at all classification levels. In case of VN_{ij}, we find that the index is inappropriate when it is calculated at a lower classification level. Expectedly, we find all its values to be 100 at the HS- 2 digit classification level. Thus, as the author argues that this index needs to be computed at a disaggregated level is validated for our sample.

Table 1: Periodic Average Magnitude of IIT for Static Indices

Index	1990-1995	1996-2001	2002-2007	2008-2013
		HS-2 Digit		
B_{ij}	0.62	0.57 (*–8.06*)	0.53 (*–7.02*)	0.49 (*–7.55*)
GL_{ij}	38.17	44.96 (*17.79*)	53.06 (*18.02*)	55.37 (*4.35*)
GLC_{ij}	40.93	50.1 (*22.40*)	60.6 (*20.96*)	70.99 (*17.15*)
AQ_{ij}	36.3	46.78 (*28.87*)	56.5 (*20.78*)	64.48 (*14.12*)
VN_{ij}	99.73	99.94 (*0.21*)	100 (*0.05*)	100 (*0*)
		HS-4 Digit		
B_{ij}	0.72	0.66 (*–8.33*)	0.6 (*–9.09*)	0.6 (*0.00*)
GL_{ij}	26.12	28.45 (*8.92*)	32.58 (*14.52*)	30.74 (*–5.65*)
GLC_{ij}	27.31	31.51 (*15.38*)	37.7 (*19.64*)	39.47 (*4.69*)
AQ_{ij}	25.99	27.83 (*7.08*)	31.59 (*13.51*)	30.47 (*–3.55*)
VN_{ij}	81.37	89.08 (*0.09*)	98.56 (*0.10*)	99.58 (*0.01*)
n	1198.67	1221.83 (*1.93*)	1236 (*1.15*)	1216.67 (*–1.56*)
		HS-6 Digit		
B_{ij}	0.78	0.72 (*–7.69*)	0.67 (*–6.94*)	0.67 (*0.00*)
GL_{ij}	14.04	16.63 (*18.45*)	21.33 (*28.26*)	22.48 (*5.39*)
GLC_{ij}	15.36	18.86 (*22.79*)	25.64 (*35.95*)	29.5 (*15.05*)
AQ_{ij}	14.41	16.88 (*17.14*)	21.37 (*26.60*)	22.75 (*6.46*)
VN_{ij}	66.32	78.88 (*18.93*)	95.16 (*20.63*)	98.7 (3.72)
n	4523.33	4843.67 (*7.08*)	5035 (*3.95*)	4919 (*–2.30*)

Note: Figures in the parenthesis represent growth in percentage term. *n* represent number of commodity groups. For HS- 2 digit classification *n* = 97 for all years.

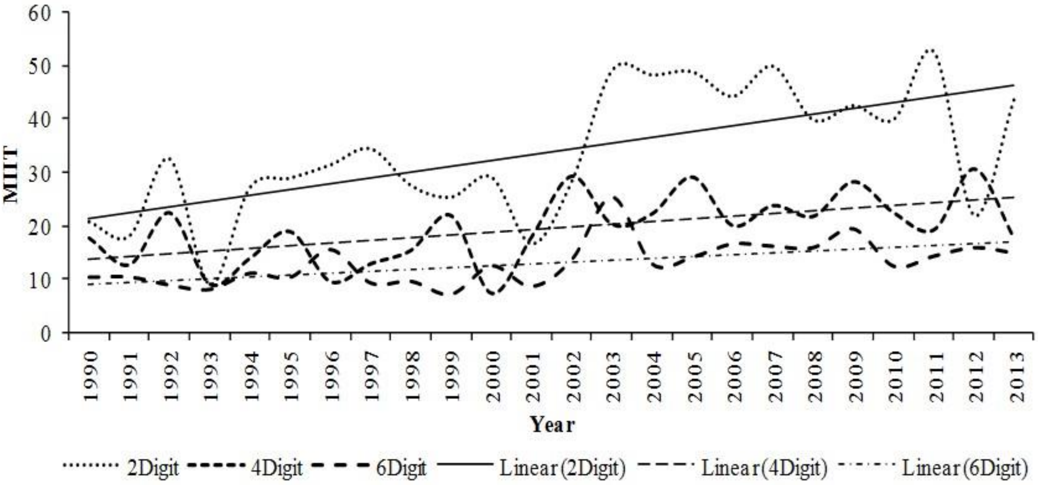

Figure 3: Magnitude of India's Marginal IIT

The pair-wise correlation between different static indices calculated at all the HS classification levels turn out to be statistical significant at 1% level. More importantly, the signs between the indices turn out to be as expected. Thus, given the small size of the bias and the strong correlation between the indices makes it conducive to choose any one index for further empirical analysis.

We argue that much of the growth in IIT which occur in the period after 2002 can be linked with India's improved trade performance in the second decade of the liberalization period. Furthermore, as articulated above one finds that empirical literature on India's IIT argues that liberalization process in India has allowed Indian firms to specialize and produce only a subset of product lines within an industry while import the different technological variations of the same product. These arguments led us to examine the dominant form of IIT in industries catering to such trade and then study whether the liberalization process has led India to gain relative efficiency in production of goods engaged in different forms of IIT.

In what follows, we segregate 21 industries as classified under Indian Trade Clarification into groups catering to *intra* & *inter*-industry trade across HS- 2, 4 & 6 digit classification levels. In other words, industries having high average value of GL_{ij} categorize into IIT and the remaining ones characterize of inter- industry trade. See, Table 2.[13] The common Indian industries catering to high IIT across the HS classification levels are Chemical [HS- 28 to 38], Plastics & Rubber [HS- 39 to 40], Stone, Cement and Glass [HS- 68 to 70], Base Metals [HS- 72 to 83], Machinery & Mechanical Appliances [HS- 84 to 85] and Transport Equipment [HS- 86 to 89].[14] Table 3 provides the percentage of IIT in new trade flows at HS- 6 digit level for these selected industries. Both GL_{ij} and $MIIT_{ij}$ indicate that there has been a positive growth in these selected industries.[15]During the period of 2002-08 the magnitude of IIT showed minor fluctuations across all HS classification levels. Furthermore, bearing industry of Transport Equipment's all other industries average share of IIT in new trade flows is around 15-20%. Stone, Cement & Glass which had on an average 16% flow of marginal IIT had the least share in India's total trade value. While, industry of Transport Equipment having averagely 3.45% share in India's total trade value had the least marginal IIT. This is perhaps because of the number of product lines associated with these industries.[16]

Table 2: Manufacturing Industries of India Cater to Intra-Industry Trade: 1990-2013

HS Classification Level	***Intra*-Industry Trade**		*Avg.* GL_{ij} of Other Industries
	Industries	*Avg.* GL_{ij}	
2 Digit	Chemicals; Plastic & Rubber; Stone, Cement & Glass; Gems & Jewellery; Base Metals; Machinery & Mechanical App.; Transport Equip.; Arms & Ammunitions; Misc. Manufacturers	65.79	25.73
4 Digit	Chemicals; Plastic & Rubber; Stone, Cement & Glass; Gems & Jewellery; Base Metals; Machinery & Mechanical App.; Transport Equip.; Optical, Photographic, Surgical & Clock; Arms & Ammunitions; Misc. Manufacturers	41.15	13.51
6 Digit	Chemicals; Plastic & Rubber; Wood, Charcoal & Coke; Stone, Cement & Glass; Base Metals; Machinery & Mechanical App.; Transport Equip.; Optical, Photographic, Surgical & Clock; Transport Equip.; Misc. Manufacturers	30.60	10.44

Considering 1990 as the base year, we find that compared to other industries Rubber & Plastics have experienced large variability in marginal IIT. For instance, in the years 1994 and 1996 the industry depicted high values and again in 2000 it witnessed a sharp fall. Industry of Stone, Cement & Glass had a high growth with fluctuations until a steep fall in 2012 and 2013. The remaining industries did not show much variability in the index values. Compared to the base year of 1990 we find that industries of Chemical Products and Machinery & Mechanical App. that have the largest share in total trade and also the outmost number of product lines had almost similar levels of growth until 2000. However, Chemical industry quite drastically in 2002 and then a steady fall. On the other hand, industry of Machinery & Mechanical App. improved its value in 2008 and then its decline from 2009 onwards.

Table 3: Marginal IIT for Selected Manufacturing Industries of India

Year	Chemical	Plastics & Rubber	Stone, Cement & Glass	Base Metals	Machinery & Mechanical App.	Transport Equip.
1990	11.79	7.19	5.96	15.25	19.06	11.58
1991	13.12	9.2	10.6	7.58	18.29	6.12
1992	16.69	10.61	5.86	7.63	16.31	12.57
1993	6.44	10.63	10.19	7.12	14.76	1.01
1994	13.56	34.4	11.37	12.69	18.59	4.57
1995	15.6	19.36	7.34	12.93	19.54	17.4
1996	10.29	36.76	15.71	20.22	25.86	4.86
1997	14.28	11.52	14.12	17.12	14.26	6.29
1998	11.43	17.08	10.97	13.52	15.28	18.7
1999	12.79	25.11	13.1	9.86	17.9	14.37
2000	9.7	13.01	12.49	10.46	24.27	18.23
2001	16.66	12.18	13.78	14.75	16.53	4.73
2002	26.42	26.21	16.39	12.55	18.87	12.49
2003	24.26	25.94	15.41	16.78	21.83	14.41
2004	21.23	27.45	19.95	18.95	23.87	19.54
2005	21.39	30.05	19.02	20.7	24.5	17.42
2006	20.14	24.37	23.96	13.84	24.64	12.86
2007	22.04	21.59	23.82	18.23	20.91	10.19
2008	17.41	27.65	23.82	22.52	28.89	10.27
2009	17.24	20.3	20.36	21.96	31.26	9.34
2010	18.57	22.4	23.6	14.22	18.99	25.4
2011	18.5	23.59	32.32	17.47	25.61	15.49
2012	16.22	10.41	18.37	22.95	21.75	10.88
2013	18.75	19.04	13.22	18.17	15.41	18.81
Average	*16.44*	*20.25*	*15.9*	*15.31*	*20.72*	*12.4*
Variance	*23.35*	*68.8*	*42.81*	*22.34*	*21.02*	*35.12*
Trend	*0.387*	*0.323*	*0.734*	*0.444*	*0.294*	*0.367*

3.2. Forms of Intra-Industry Trade

This section uses the *unit value dispersion criterion* to disentangle total IIT (computed using GL_{ij}) into its various forms at the HS- 6 digit classification level.[17] Following it, using Balasaa (1965) we compute the share of RCA for commodity groups engaged in IIT.[18]

One can find from Fig. 4 that the industry of Chemical Products exhibits prevalence of IIT in different technology products [V-IIT] to be more. Interestingly, by considering 1990 as the base year we find share of similar technology products in IIT has shown a rising trend in lieu of a decline in V-IIT. For instance, the share of H-IIT and V-IIT rose from around 10% and 89% in 1990 to 16% and 83% in 2013, respectively. Average annual growth for the share of H-IIT & V-IIT in IIT has been around 4% and –0.2%, respectively. In V-IIT, bearing the periods of 1996, 2010 and 2013 the export of *high* technology products (*h*-VIIT) has been low compared to the *low* technology ones (*l*-VIIT). However, by considering 1990 as the base year we find the share of *h*-VIIT to rise in lieu of a declining share of *l*-VIIT. On an average out of 730 commodities traded around 86% of them had simultaneous export and import. Out of all the commodities traded around 62% and 92% were traded two ways in 1990 and 2013, respectively. The annual average growth of commodity groups engaged in IIT is around 2.5%. Considering the share of commodity groups engaged under H-IIT in total IIT we find the average annual growth to be around 4%. Furthermore, the average annual growth computed for the share of *l*-VIIT and *h*-VIIT in V-IIT has been around – 0.17% and 1.18%, respectively.

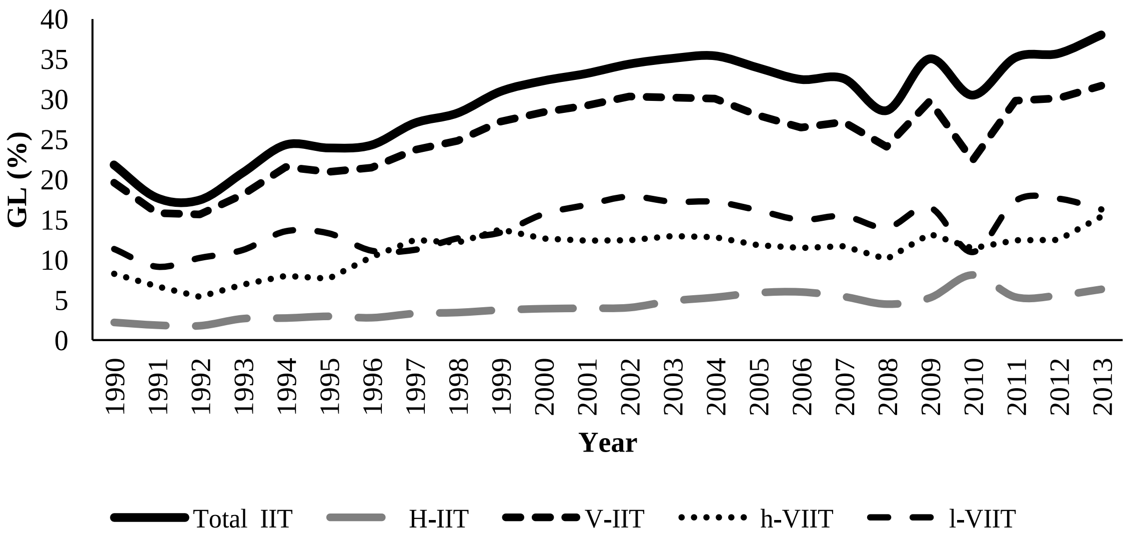

Figure 4: Types of Intra-Industry Trade: Industry of Chemical Products

The industry of Rubber and Plastics too witnessed the share of V-IIT to be high. The average annual growth of share of V-IIT in total IIT fell at around –0.89%. For instance, the share of V-IIT fell from 92% in 1990 to 73% in 2013. In V-IIT, averagely *l*-VIIT dominates *h*-VIIT. However, the contribution of *l*-VIIT to total IIT has fallen from 70% in 1990 to 41% in 2013. Comparing *h*-VIIT and *l*-VIIT from their base period in 1990 we find that growth of the former has been rapid than the latter. Interestingly, after 2009 we find a counter cyclical relation between the two types of V-IIT.

See, fig. 5. In 1990, out of 182 commodity groups only 130 had a two way trade whereas in 2013 it was 266 out of 295 commodity groups. On an average around 92% of the commodity groups are engaged in IIT. The share of commodity groups engaged in IIT has an average annual growth rate of around 5%. We also find that the share of commodity groups engaged under H-IIT in total IIT is averagely grew around 13%. While comparing the share of commodity groups under *h*-VIIT and *l*-VIIT in V-IIT the average growth have been positive for both but latters is significantly more (i.e., 22% & 6%).

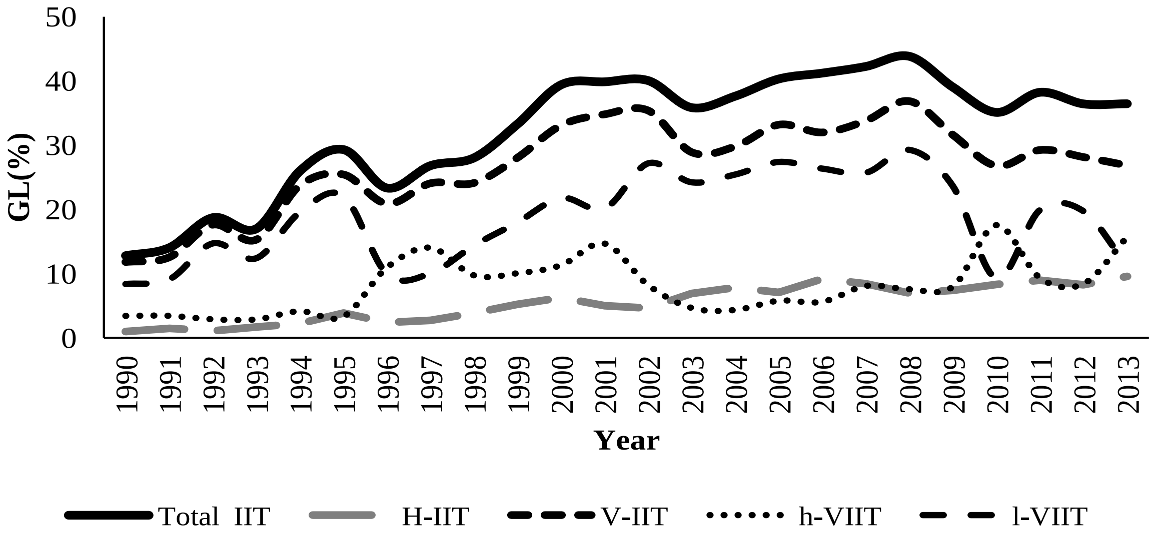

Figure 5: Types of Intra-Industry Trade: Industry of Rubber & Plastics

Yet again we find that the share of V-IIT to be more as compared to H-IIT in the industry of Stone, Cement and Glass; see, Fig. 6. Over the entire sample period the share of V-IIT has been around 90%. It is only after 2002 that average share of H-IIT somewhat rose [i.e., from around 1.4% (1990-02) to around 5% (2003-13)]. In the case of V-IIT, contribution of *l*-VIIT has been higher but it shows a declining trend. For instance, around 93% of V-IIT has been contributed by *l*-VIIT in 1990 while it fell to around 50% in 2013. Compared to base year of 1990 we observe that H-IIT and *h*-VIIT to have risen more than the other types of IIT. On an average, around 89% of the commodity groups have the property of IIT. In 1990, around 71% of the commodity groups were engaged in IIT while in 2013 it rose to 97%. The average annual growth rate for commodities engaging in IIT is around 2.5%. For *h*-VIIT &*l*-VIIT average annual growth has been around 22% and 1%, respectively signifying a shift in dominance. Commodity groups under H-IIT also grew rapidly with around 33% as the average growth rate.

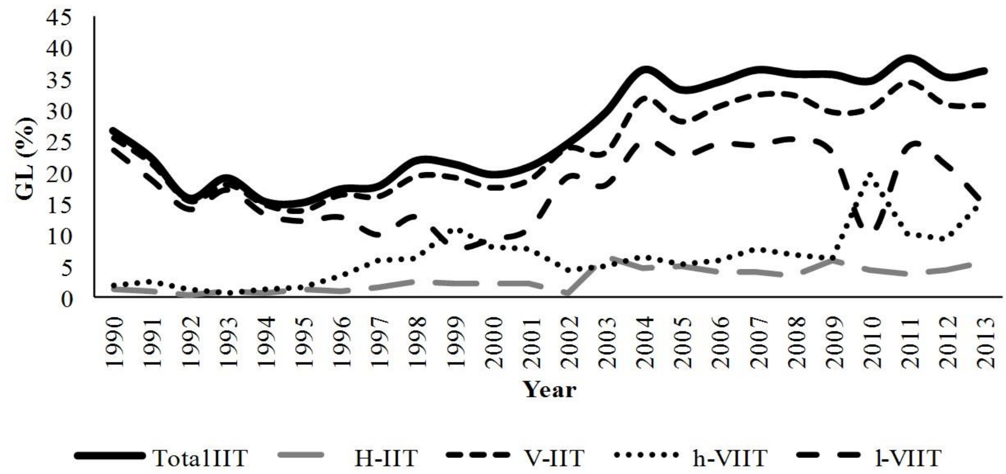

Figure 6: Types of Intra-Industry Trade: Industry of Stone, Cement & Glass

A similar case is repeated in terms of share of V-IIT in the industry of Base Metals. Compared to V-IIT the share of H-IIT in total IIT is relatively low. Over the entire period the average share of H-IIT is around 15%. The average annual growth of H-IIT has been around 5% whereas that of V-IIT has been around 1%. The share of H-IIT & V-IIT in total IIT had a growth rate of 5% and –0.89%, respectively. While comparing the share of *l*-VIIT and *h*-VIIT in V-IIT, though we find the average share of the former is dominant but there is a shift of dominance from the former to the latter. For instance, one can find from figure 7 that the share of *l*-VIIT and *h*-VIIT were around 77% & 22% in 1990 and around 38% & 62% in 2013, respectively. On an average around 89% of the commodity groups have both simultaneous exports and imports with the major chunk in V-IIT. In 1990 64% of the commodity groups were engaged in IIT while it rose to 98% in 2013. The average annual growth of commodity groups under IIT was around 2%. Furthermore, commodity groups under *h*-VIIT and *l*-VIIT grew around 14% & 1.5%, respectively. Growth in share of commodity groups under H-IIT in total IIT has been around 5%.

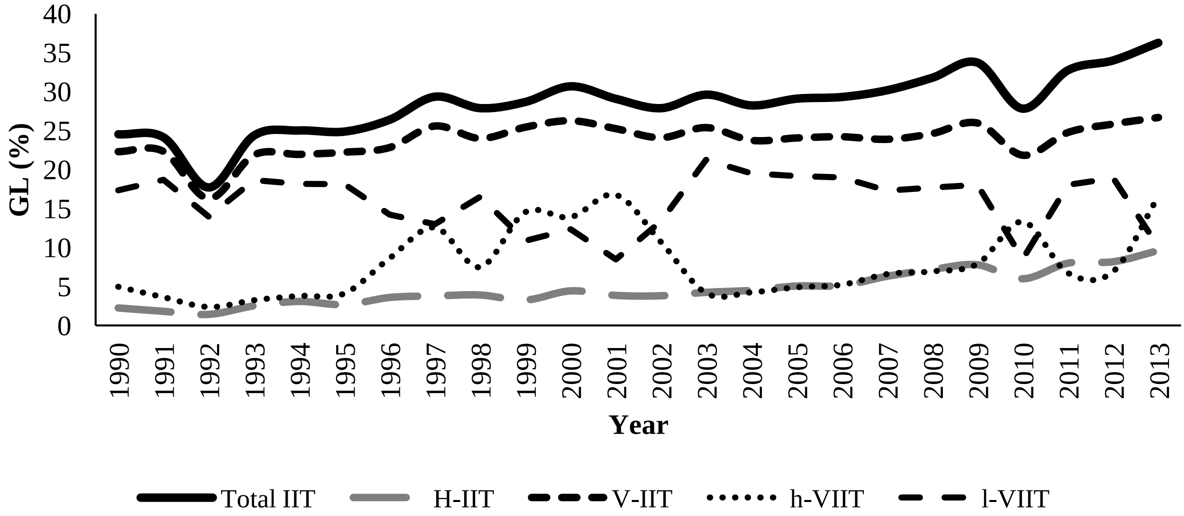

Figure 7: Types of Intra-Industry Trade: Industry of Base Metals

In case of the industry of Machinery and Mechanical Appliances, we find that compared to V-IIT average share of H-IIT for the entire study period has been low at around 6%. There has been marginal rise in the share of H-IIT from around 3% in 1990 to around 7% in 2013. Nonetheless, the average annual growth for share of H-IIT and V-IIT in total IIT has been around 6% and –0.10%, respectively. In the case of V-IIT we find that *l*-VIIT dominates *h*-VIIT. Moreover, growth rate for share of *l*-VIIT and *h*-VIIT in V-IIT has been around 13% and 4%, respectively. Thus, unlike the other industries here *h*-VIIT has not surpassed its counterpart; see, fig. 8. On an average around 90% of the commodity groups have simultaneous exports and imports. Average growth rate for commodity groups under IIT has been at 4%. Interestingly, we find that share of commodity groups engaged in *h*-VIIT to grow rapidly than *l*-VIIT (i.e., average annual growth being 14% and 4%, respectively). Even the share of commodity groups engaged in H-IIT in total IIT grew by around 6%.

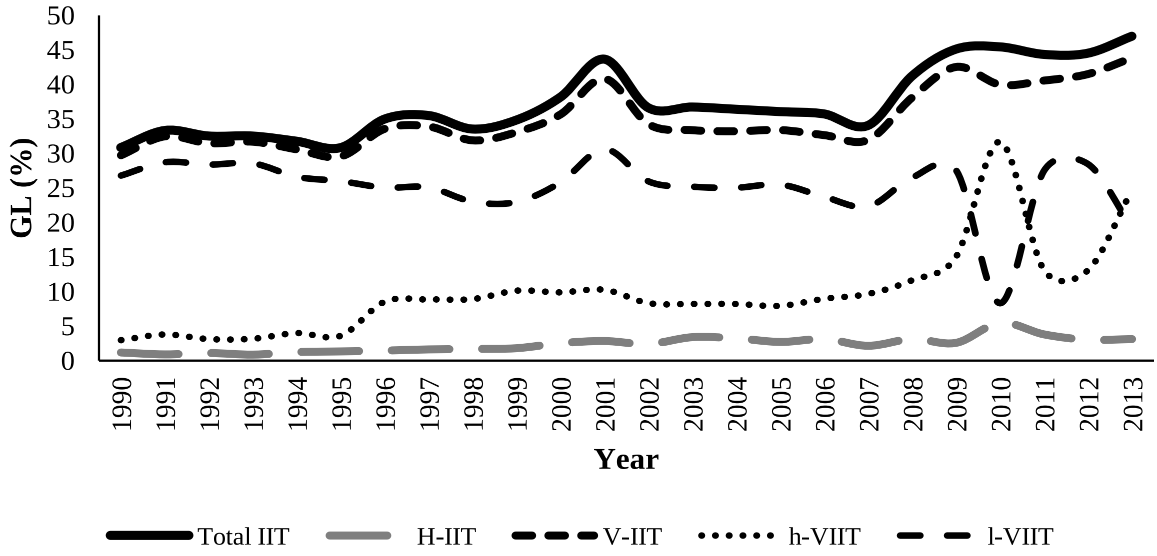

Figure 8: Types of Intra-Industry Trade: Industry of Machinery & Mechanical Appliances

We find that in the industry of Transport Equipment for the entire sample period the share of H-IIT is marginal compared to that of V-IIT is being around 7% only. However, the annual average growth rate for share of H-IIT & V-IIT in total IIT has been at 19% and 0.2%, respectively. In case of V-IIT, *l*-VIIT had majority of share with an average of 71%. But for the period between 1997-2001 and 2013, *h*-VIIT surpassed *l*-VIIT; see, figure 9. On the other hand, average annual growth rate reveals contribution of *h*-VIIT and *l*-VIIT in V-IIT grew around 26% and –0.7%, respectively. Contrary, to the other industries we find that the percentage of commodity groups having the property of IIT is relatively less. Only, averagely around 77% of the commodity groups have simultaneous exports and imports. However, commodity groups engaging in IIT grew by around 3%. Like other industries too average annual growth rate for *h*-VIIT has been better then *l*-VIIT (i.e., 25.60% and –0.7%, respectively). Even the share of commodity groups for H-IIT among IIT grew by 19%.

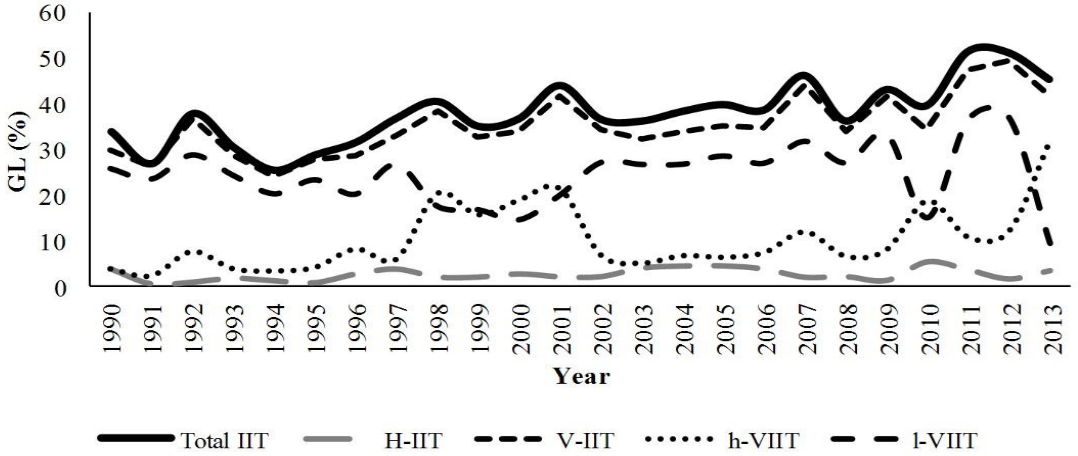

Figure 9: Types of Intra-Industry Trade: Industry of Transport Equipment

Some of the common observations that we make from the preceding discussion is that in these industries number of commodity groups which are traded simultaneously have increased from about 60% in 1990 to above 90% in 2013. More importantly, we observe that all selected manufacturing industries have *l*-VIIT as the major contributor to IIT with *h*-VIIT and H-IIT gaining momentum towards the end of the last decade. In other words, trade India faces deterioration in its terms of trade; since we have $\frac{P_x}{P_m} \equiv \frac{UV_x}{UV_m} < 0.85$ in the majority of commodity groups. Such evidences are common observations found in developing nation and particularly entangles with argument of new trade theories that vertical IIT can be explained by comparative advantage theory; see, Martini (1997), Baleix and Egido (2010), Ito and Okubo (2012), among others. These arguments leave us to examine whether such trade leads to gains. We compute the revealed comparative advantage at the HS- 6 digit level for each commodity groups for these said industries which have the property of IIT; see, Table 4.

Table 4: Commodity Groups Having RCA at HS- 6 Digit Level: 1990 -2013

Industries		Commodity Groups		Revealed Comparative Advantage [RCA]				
						Share.		Mean Test
		Mean	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*	$\lvert t \rvert$
Chemical	H-IIT	89.70	26.01	32.45	11.71	36.42	12.25	16.26[a]
	V-IIT	542.20	85.17	184.67	41.48	33.86	4.30	33.09[a]
	l-VIIT	305.87	48.93	99.16	21.48	32.36	3.95	31.15[a]
	h-VIIT	236.33	47.91	85.83	22.26	36.07	5.39	23.05[a]
Plastics & Rubber	H-IIT	30.41	13.34	5.37	3.49	16.78	7.49	11.57[a]
	V-IIT	154.83	22.32	28.20	9.01	17.98	4.51	35.35[a]
	l-VIIT	107.67	27.59	20.62	8.70	18.78	5.27	19.66[a]
	h-VIIT	47.62	24.83	7.58	4.66	15.99	5.92	9.29[a]
Stone, Cement & Glass	H-IIT	12.83	6.81	2.37	2.22	18.48	16.06	12.86[a]
	V-IIT	111.16	14.49	23.20	4.38	20.94	3.36	35.1[a]
	l-VIIT	81.70	17.83	17.41	5.04	21.38	4.24	22.35[a]
	h-VIIT	29.45	17.77	5.79	4.28	20.66	9.48	7.99[a]
Base Metals	H-IIT	81.29	33.63	24.79	11.23	30.12	7.12	11.48[a]
	V-IIT	420	37.82	113.25	22.77	26.78	3.74	61.5[a]
	l-VIIT	281.62	70.55	77.16	26.29	26.98	4.06	21.06[a]
	h-VIIT	138.41	75.53	37.75	20.62	27.74	6.69	8.59[a]
Machinery & Mechanical Appliances	H-IIT	41.41	15.44	7.08	3.77	16.27	5.14	13.67[a]
	V-IIT	645.79	89.42	97.95	27.06	15.21	3.61	34.64[a]
	l-VIIT	475.5	100.59	69.41	18.21	14.94	3.25	21.8[a]
	h-VIIT	170.29	77.32	28.91	17.77	15.61	5.19	11.3[a]
Transport Equipment	H-IIT	6.75	2.95	1.33	1	21.67	21.63	9.43[a]
	V-IIT	83.75	15.33	19.67	4.86	23.43	4.08	25.82[a]
	l-VIIT	59.17	17.51	14.70	4.43	26.49	12.67	14.09[a]
	h-VIIT	24.58	16.60	4.95	2.34	25.48	13.19	5.97[a]

Note: *a*: significant at 1% level.

Table 5: Linear Trade Model: Share of RCA: 1990- 2013

Industries	**H-IIT**	***l*-VIIT**	***h*-VIIT**
Chemical	–0.087	0.393	0.638
Plastics & Rubber	0.439	0.317	0.454
Stone, Cement & Glass	–0.264	0.28	–0.033
Base Metals	0.244	0.048	–0.799
Machinery & Mechanical App.	0.523	0.397	0.579
Transport Equipment	0.222	0.469	0.885

Apart from the industry of Chemical & Allied Product the share of RCA attained by commodity groups across different forms of IIT for other industries has been relatively low over the period. The share of RCA for other industries was around 15% – 20% while for the Chemical industry it was around 35%. For the industries of Plastics and Rubber; Stone, Cement & Glass and Transport Equipment the share of RCA have been highest for India's export of low technological products. In case of industries of Chemical; Base Metals and Machinery and Mechanical Appliances the share of RCA products have been relatively higher for the goods traded with similar technologies. However, it is also important to note here that the share of RCA for the different forms of IIT do not change much within an industry. The low value of standard deviation for the share of commodity groups having RCA reveals not much change in the share over the time period. However, the trend values reported in Table 5 indicates in most cases the share of RCA has marginally improved over time. The results from paired mean test suggest that means of commodity groups engaged in IIT and commodity groups with RCA across the different forms of IIT over time are statistically different at 1% level of significance.

Given this distinctive attribute of India's IIT we attempt to econometrically examine in the following section as to what determines the magnitude of IIT and its different forms in these Indian industries over the two half decades of the liberalization process.

4. Empirical Analysis

Addressing to the possible problems of non-stationarity, cross sectional dependence, heteroskedasticity and serial autocorrelation, this section econometrically identifies the determinants of the magnitude of IIT, *l*-VIIT, *h*-VIIT and H-IIT of the Indian industries at the HS- 6 digit level over the period 1990-2013. Section 4.1 discusses data and variables. In Section 4.2, we discuss the panel unit root test developed by Pesaran (2007) and the estimation method under the assumption of large T asymptotics. Section 4.3, explore the empirical findings from our estimated model.

4.1 Data and Variables

The dependent variable [i.e., magnitude of total IIT/*l*-VIIT/*h*-VIIT/H-IIT] in our paper is extracted from section 3. In doing so, we constructed a balanced panel for six industries combining data on trade share, net exports, RCA, share of products engaged in IIT and its different forms from UN Comtrade database and Anti-dumping initiations from Global Antidumping Database; The World Bank. In what follows, we discuss the rationale behind our explanatory variables.

Product Share: The magnitude of i^{th} industry's intra-industry trade along with its different forms is expected to improve if the ratio of number of commodities engaged in such trade to total number of commodities involved in trade (i.e., both *inter* and *intra*-industry trade) increases. In other words, as the number of commodities engaged in IIT increases, it reflects that domestic firms in a particular industry are able to exploit scale economies and cater to consumer preference for diversity; Krugman (1979), Lancaster (1979), Corden (1979), Greenaway *et al*. (1994), Davis (1995), among others.

Firms in each country would produce a subset of varieties within an industry and export them while the varieties of the same commodity that are not produced would be imported; see, Veeramani (2009).

Net Exports: In order to examine whether it is the rise in the i^{th} industry's rise in imports or exports that determine the magnitude of IIT with its different variations, we consider the difference in exports and imports of the industry. Thus, instead of trying to posit a sign of its coefficient, we leave it to be determined empirically. This variable also controls for any possible bias occurring from trade balance in estimating the determinants; see, Clark and Stanley (1999), Thorpe and Zhang (2005).

Trade Share: An indicator about the relative openness of the i^{th} industry is its trade share in the country's total trade. It is expected that as the share of the i^{th} industry improves more is the possibility that it would engage in IIT. This is because a greater competition from imports leads the domestic firms to exploit scale economies and specialize in unique varieties of commodities.

Revealed Comparative Advantage: Even if i^{th} industry experiences a growth in share of IIT in its total trade by production of unique varieties, does it have a comparative advantage in their production? In other words, has the liberalization process in India have been able to reallocate productive resources to efficient product lines within the industry. In this regard, we consider both the number of products engaged in IIT, *l*-VIIT, *h*-VIIT and H-IIT having a RCA and also the share of it with the total number of products engaged in such trade. It is expected that as both the number and the share improves it would positively influence the magnitude of the said forms of trade and would help the Indian industries to gain which eventually lead to welfare gains for the country.

Anti-dumping Initiations: For members of WTO, market protection via orthodox protectionist measure are limited as the countries commit themselves towards reducing tariff rates and custom duties during their multilateral trade negotiations. As a result developing economies start using the contingent protection measures of which anti-dumping has been a relatively favourable policy choice. India is the largest initiator of anti-dumping cases across the world and the selected industries of India in this paper initiates around 83% of total India's anti-dumping initiations and face around 77% of initiations targeted. Moraga-Gonzàlez and Viaene (2015) theoretically argues that in the context of vertical IIT by using an anti-dumping initiation, a technological inferior domestic firm producing low technological good can leapfrog foreign firm superior technology good and thereby become a quality leader in the international market. This satisfies the incentives of both the domestic firm and the home government which in turn lead to welfare improvement. Based on the preceding arguments, we consider together the sum of anti-dumping initiations initiated and faced by these industries as a determinant to the magnitude of total and horizontal IIT; see, Bown and Tovar (2011) for similar arguments. For low and high vertical IIT we study the effect of anti-dumping initiations made and faced by the Indian industries, respectively to examine whether such a policy leads to quality superiority for the countries importing the superior quality product.

Table A.2 in the appendix summarizes choice of variables used, definitions and the statistical sources.

4.2 Estimation Method

The panel data structure in our case follows the typical case of asymptotics in macro panels (i.e., $T \to \infty$ and N being finite). Baltagi (2005) points out that in such panels where T is allowed to increase up to infinity, inspection of data for non-stationarity is of upmost importance. Thus, before obtaining parameter estimates, we follow Pesaran (2007) to detect any kind of unit root in the presence of cross-sectional dependence. This is because, in any macro panel study one finds that the time series are contemporaneously correlated; see, Pesaran (2015) for details.[19]

The test begins by considering a time series $\{y_{i0}, y_{i1}, \ldots, y_{iT}\}$ on the cross section units i=1(1)n generated by a simple first-order autoregressive process of the following type:

$$y_{it} = (1-\alpha_i)\mu_i + \alpha_i y_{it-1} + \varepsilon_{it}$$

where $E(\varepsilon_{it}) = 0,\ E(\varepsilon_{it}^2) = \sigma^2$. Alternatively, the above expression can be rewritten as the simple Dickey-Fuller regression as:

$$y_{it} - y_{it-1} = -(\alpha_i - 1)\mu_i + (\alpha_i - 1)y_{it-1} + \varepsilon_{it}$$

$$\text{or } \Delta y_{it} = -\phi_i \mu_i + \phi_i y_{it-1} + \varepsilon_{it};\ \varepsilon_{\text{it}} = \gamma_i f_i + u_{it}$$

where $\Delta y_{it} = y_{it} - y_{it-1},\ \phi_i = (\alpha_i - 1)$ and f_i being the unobserved common factor.

The null hypothesis being of unit root for each individual series in a panel being: $H_0 : \phi_1 = \phi_2 = \ldots = \phi_n = 0$ (i.e., that all time series are independent random walks). The alternative hypothesis based on the heterogeneity of the panel being $H_1 : \phi_i < 0, i = 1(1)n_1,\ \phi_i = 0; i = n_1 + 1(1)n$. In other words, a rejection of the null hypothesis (H_0) is interpreted as rejecting the unit root hypothesis for a fraction of cross-sectional units in the panel structure. In what follows, we discuss the test statistic of the unit root test.

Pesaran (2007) developed a test based on the t-ratio of the OLS estimate of $\hat{b}_i$ in the following cross-section augmented Dickey-Fuller (CADF) regression: $\Delta y_{it} = \alpha_i + b_i y_{t-1} + c_i \bar{y}_{t-1} + d_i \Delta\bar{y}_t + \varepsilon_{it}$.[20] The t-ratio of $\hat{b}_i$ is defined as $t_i(N, T)$ and the average of it is the (CIPS) yields the test statistic for the unit root : $CIPS(N,T) = N^{-1}\sum_{i=1}^{N} t_i(N,T)$.

Another step taken prior to obtaining parameter estimates is to detect the presence of cross-sectional dependence, heteroskedasticity and serial autocorrelation. For testing cross-sectional dependence in a sample with $N < T$ property we consider Breusch and Pagan (1980) Lagrange multiplier test with the null hypothesis of cross-sectional independence. In case of heteroskedasticity, we follow Greene (2000) modified Wald test statistic to test the presence of group-wise heteroskedasticity under the null hypothesis of homoscedasticity. See, Baum (2001) for a detailed explanation. To examine serial autocorrelation, we use Wooldridge (2002) test to detect the presence of AR(1) process under the null hypothesis of no first order autocorrelation.

Relying on large T asymptotics and nonparametric covariance matrix estimator, we estimate our regression model using Driscoll and Kraay (1998) corrected standard errors that controls for cross-sectional dependency, heteroskedasticity, auto-correlation of MA(q) process. Under this assumption, β is consistently estimated by OLS regression, which yields $\hat{\beta} = (X'X)^{-1} X'y$. The robust standard errors for the parameter estimates are then obtained as the square roots of the diagonal elements of the asymptotic covariance matrix $V(\hat{\beta}) = (X'X)^{-1} \hat{S}_T (X'X)^{-1}$; where $\hat{S}_T = \hat{\Omega}_0 + \sum_{j=1}^{m(T)} w(j,m)\left[\hat{\Omega}_j + \hat{\Omega}'_j\right]$ following Newey and West (1987). In other words, the estimation technique retains the parameter estimates of fixed effects or the pooled regression model and corrects the standard errors. The method do not hold any limiting behaviour on the cross-sectional dimension and produces a much better consistent estimate than the OLS or the SUR technique in presence of the above mentioned diagnostic problems.

4.3 Empirical Results

The results of the Pesaran (2007) panel unit root test are reported in Table A.3. The regression results testing the industry specific hypothesis about total, (low and high) Vertical and Horizontal IIT are set out in Table 6 and 7, respectively.[21] In what follows, we discuss the regression results obtained in this paper.

1. Across the model specifications, we find that the magnitude of total IIT along with its different forms to get *positively* influenced as the share of products engaged in such form of trade increases. The result indicates that the liberalization process have led the Indian industries to shift its focus from specializing only in export oriented products to exploit scale economies and produce a subset of different qualities in a product line; see, Helpman (1990) for similar arguments. For instance, across all the industries we find the growth in share of products engaged in total IIT from 1990 to 2013 has been around 40%. The relatively lower coefficient values of the variable in case of low vertical IIT points out that over the years Indian industries have moved away from specializing from *low* to *high* technological products.[22]

2. For (low and high) vertical and horizontal IIT, net exports have yielded a *negative* coefficient value with almost similar coefficient values across the model specifications. In case of only horizontal IIT, the statistical significance of the variable drops from 1% to the 5% level. The negative coefficient value indicates that it is the rise in the industry's imports that has been improving the magnitude of the said forms of IIT.

3. Trade share of the i^{th} industry in India's total trade have had a mixed result. In case of India's export of lower technological products (i.e., *l*-VIIT) we find that the magnitude of it falls as the share of the industry's trade in India's total trade improves. Even though low vertical IIT dominates India's IIT over the years but it has fallen with the rise in trade volume. Alternatively, the positive coefficient value of trade share for the magnitude of high vertical and horizontal IIT is also explained with the declining share of low vertical IIT in the industry's trade. Thus, one can argue that as these select industry opens up more firms in the industry would specialize in producing superior or similar technological products relative to the quality of the imports. Such a finding reiterates our arguments laid in section 3 as well as for the variable product share.

4. Protectionism in the form of total anti-dumping activities does not affect the industry's magnitude of IIT and H-IIT. Such a result coheres with that obtained in Bagchi *et al*. (2015) where the authors argue that anti-dumping initiations of India lack conventional economic

arguments. On the other hand, we find anti-dumping initiations taken up by foreign countries have a *negative* effect on Indian industries export of superior technological product (*h*-VIIT). As expected, the result indicate that the technologically inferior foreign firm would use anti-dumping initiations to leapfrog the Indian firm's superior quality and thereby become the quality leader in the international market.[23]

5. The magnitude of total and low vertical IIT improves as both the number as well as share of the products having a RCA engaged in these forms improves. For high vertical IIT (i.e., India's export of superior technological goods) we find that its number have positively benefitted its magnitude while its low share have had a crowding out effect. On the other hand, the magnitude of horizontal IIT is *negatively* influenced by the number of products within the form which has a RCA. This could be because of the low occurrence of commodities engaged in H-IIT and also the low number of products with RCA; see, Table 4 reported in Section 3.

6. Lastly, the constant term in all our model specifications turns out to be negative and statistically significant at 1% level. In other words, one can argue that when all of our regressor are set to zero then the regression equation predicts that the expected mean response for magnitude of total, (low and high) vertical and horizontal IIT will be negative. However, in our regression model variables as net exports and trade share can never be realistically set to zero.

Table 6: Regression Results: Magnitude of Total, (Low and High) Vertical and Horizontal IIT [With Share of RCA]

Variables	**Total IIT**		***Low* Vertical IIT**		***High* Vertical IIT**		**Horizontal IIT**	
	Model I	Model II	Model I	Model II	Model I	Model II	Model I	Model II
Product Share	0.01313 (2.90)[b]	0. 01327 (2.85)[b]	0.01970 (8.57)[a]	0. 01851 (7.61)[a]	0.03784 (9.63)[a]	0 .03921 (9.98)[a]	0.10315 (10.49)[a]	0.10296 (10.30)[a]
Net Exports	– 2.84e-06 (–0.95)	*NI*	– 0.00001 (–4.71)[a]	*NI*	– 0.00001 (–4.66)[a]	*NI*	–0.00001 (–3.58)[b]	*NI*
Trade Share	*NI*	– 0. 02496 (–1.23)	*NI*	–0.02169 (–2.30)[b]	*NI*	0. 02476 (6.36)[a]	*NI*	0. 01663 (3.18)[b]
Total ADA	–0.00031 (0.44)	0. 00016 (0.21)	*NI*	*NI*	*NI*	*NI*	0.00028 (0.45)	8.52e-06 (0.02)
ADI	*NI*	*NI*	0. 00029 (0.33)	0.00152 (1.76)	*NI*	*NI*	*NI*	*NI*
ADF	*NI*	*NI*	*NI*	*NI*	–0.00241 (3.36)[b]	–0.00316 (–4.18)[a]	*NI*	*NI*
RCA Share	0.02891 (8.68)[a]	0. 03175 (8.85)[a]	0.03233 (0.52)	0.34653 (2.86)[b]	–0.00287 (–1.61)	–0.00505 (–2.96)[b]	0.00017 (0.11)	–0.00110 (–0.73)
Constant	–2.60251 (–6.03)[a]	– 2.52651 (–6.08)[a]	–2.98288 (10.61)[a]	–3.72195 (–9.78)[a]	–3.64491 (–20.14)[a]	–3.69586 (–18.47)[a]	–4.67301 (–26.47)[a]	–4.69573 (–23.50)[a]
R^2	0.32	0.33	0.48	0.52	0.76	0.75	0.78	0.77
Average VIF	1.11	1.12	1.16	1.15	1.08	1.09	1.08	1.12
$F_{4,5}$	23.19[a]	31.10[a]	53.18[a]	56.12[a]	27.34[a]	29.74[a]	105.80[a]	69.79[a]
Hausman Specification test $\chi^2_{(4)}$	11.97[b]	20.18[a]	3.44	14.14[a]	0.41	0.84	2.77	5.25
Breusch-Pagan LM test of independence: $\chi^2_{(15)}$	35.53[a]	41.03[a]	—	60.10[a]	—	—	—	—
Modified Wald test: group heteroskedasticity: $\chi^2_{(6)}$	106.60[a]	150.14[a]	—	74.45[a]	—	—	—	—
Wooldridge test for AR(1): $F_{1,5}$	12.85[b]	15.81[b]	13.00[a]	12.36[b]	5.44[c]	6.25[c]	13.17[b]	12.28a

Note: *t*- statistics are reported in the parenthesis. *a*, *b* and *c*: denote statistical significance at 1%, 5% and 10%, respectively. NI: Not included.

Table 7: Regression Results: Magnitude of Total, (Low and High) Vertical and Horizontal IIT [with No. of RCA commodities]

Variables	**Total IIT**		***Low* Vertical IIT**		***High* Vertical IIT**		**Horizontal IIT**	
	Model I	Model II	Model I	Model II	Model I	Model II	Model I	Model II
Product Share	0.00982 (1.85)	0. 00931 (1.64)	0. 01952 (8.80)[a]	0.01417 (4.97)[a]	0.03781 (9.58)[a]	0.03581 (8.84)[a]	0.10579 (11.27)[a]	0.11256 (11.15)[a]
Net Exports	–4.27e-06 (–1.41)	*NI*	–0. 00001 (–4.96)[a]	*NI*	–0.00001 (–4.59)[a]	*NI*	–0.00011 (–3.72)[b]	*NI*
Trade Share	*NI*	–0.01596 (–0.91)	*NI*	–0.02660 (–2.60)[b]	*NI*	0.01379 (0.97)	*NI*	0.02895 (6.09)[a]
Total ADA	0.00029 (0.45)	0.00013 (0.19)	*NI*	*NI*	*NI*	*NI*	0.00057 (1.30)	0.00057 (1.11)
ADI	*NI*	*NI*	0.00069 (0.92)	0. 00078 (1.05)	*NI*	*NI*	*NI*	*NI*
ADF	*NI*	*NI*	*NI*	*NI*	–0.00253 (–3.81)[b]	–0.00378 (–3.34)[b]	*NI*	*NI*
RCA Number	0.00331 (4.75)[a]	0.00388 (4.82)[a]	–0.00054 (–0.93)	0.006844 (3.91)[b]	–0.00008 (–0.16)	0.00825 (8.77)[a]	–0.00212 (–1.30)	–0.00754 (–4.82)[a]
Constant	–1.94998 (4.20)[a]	–1.84957 (–4.09)[a]	–2.84851 (–24.52)[a]	–2.65619 (19.75)[a]	–3.70954 (–20.07)[a]	–3.91548 (17.72)[a]	–4.67893 (–26.49)[a]	–4.81893 (24.70)[a]
R^2	0.28	0.27	0.48	0.54	0.76	0.80	0.78	0.78
Average VIF	1.18	1.81	1.16	1.97	1.29	1.71	1.38	1.95
$F_{4,5}$	11.50[a]	21.80[a]	51.26[a]	116.15[a]	32.08[a]	206.40[a]	165.28[a]	79.37[a]
Hausman Specification test $\chi^2_{(4)}$	10.40[b]	19.88[a]	6.65	24.48[a]	4.02	13.56[a]	2.30	4.42
Breusch-Pagan LM test of independence: $\chi^2_{(15)}$	37.46[a]	44.51[a]	—	33.57[a]	—	68.83[a]	—	—
Modified Wald test: group heteroskedasticity: $\chi^2_{(6)}$	149.72[a]	155.14[a]	—	246.65[a]	—	196.92[a]	—	—
Wooldridge test for AR(1): $F_{1,5}$	11.47[b]	14.04[b]	8.20[b]	8.08[b]	5.06[c]	6.33[c]	9.57[b]	8.54[b]

5. Summing Up

Addressing the problem of choice of index and categorical aggregation of data, this study computes the magnitude of intra-industry trade at different disaggregated levels of trade data using varied indices. The result shows that, like any other country in the world, the liberalization process in India have induced IIT to play an increasingly dominant role in the country's total merchandise trade. We find that across HS- 2, 4 and 6 digit classification levels it is the industry of Chemical; Plastics & Rubber; Stone, Cement & Glass; Base Metals; Machinery & Mechanical Appliances and Transport Equipment that have shown relatively high magnitude of IIT. The above average magnitude of total IIT across the six industries have been for the industries of Machinery & Mechanical appliances, Rubber & Plastics and Transport Equipment. Industries of Chemical, Plastics & Rubber and Base Metals have shown a relatively high magnitude of IIT in *similar* technological goods. Both the industries of Machinery & Mechanical appliances and Transport Equipment have shown high magnitude with export of *low* as well as *high* technological good. Altogether, the six manufacturing industries we find the dominant form of IIT has been export of *low* technological good (*l*-VIIT), while trade in *similar* technological good (H-IIT) and export of *high* technology good (*h*-VIIT) have gained some momentum after the global recessionary period in 2008.This indicates that India has experienced a deterioration in its terms of trade. Given the argument of IIT that shift of resources takes place within an industry from inefficient to efficient product lines, we examine as to what percentage of commodities engaged in different forms of IIT adhere to the comparative advantage hypothesis. Our result show that commodities from industries of chemical, Base Metals and Transport Equipment which are engaged in different forms of IIT have a relatively high number as well as share of revealed comparative advantage. Overall, the number of commodities engaged in different forms of IIT with RCA have not covered for half of those traded. However, the number as well as the share have shown improvement over the years.

The regression results for the magnitude of total, (low and high) vertical and horizontal IIT for the selected industries have benefitted as more of commodities at the HS- 6 digit level are engaged in the said forms of trade. One also finds that the magnitude of India's export of *low* technological products have fallen with the industry's rise in trade share. On the other hand, as argued above we find that the regression result confirms our hypothesis that the magnitude of *high* vertical and horizontal IIT have improved with the improvement in the industry's share of trade over the years. Anti-dumping initiations of India have not affect the magnitude, while those face by these industries have negatively influenced India's export of high technological products. This points out that the foreign firm producing *low* technological products have used such a protectionist measure to leapfrog India's technological advancement in select products. The number of products with RCA have positively aided the magnitude of IIT, however the share of it only benefits *low* vertical IIT. Moreover, the low share of RCA in India's export of high technological products crowds out its magnitude.

To sum up, the results obtained by us indicate that the liberalization process in India have influenced the role of intra-industry trade by allowing firms within an industry to exploit scale economies and produce different varieties of a product. However, the rise (yet small) in the magnitude of India's export of *high* technological products can help to shift the terms of trade in her favour by moving productive resources within the industry to produce the high technological products.

Appendix

Table A.1: Indices to Measure Magnitude of IIT

Author(s)	Index
Michaely (1962)	$MH_{ij} = \left[1 - \frac{1}{2}\sum_{i=1}^{n}\left\lvert \frac{X_i}{\Sigma X_i} - \frac{M_i}{\Sigma M_i} \right\rvert \right] \times 100$
Balassa (1966)	$B_{ij} = \frac{1}{n}\sum_{i=1}^{n}\frac{\lvert X_i - M_i \rvert}{(X_i + M_i)}$
Grubel & Lloyd (1971)	$GL_{ij} = \left[1 - \frac{\sum_{i=1}^{n}\lvert X_i - M_i\rvert}{\sum_{i=1}^{n}(X_i + M_i)}\right] \times 100$
Grubel & Lloyd (1975)	$GLC_{ij} = \frac{GL_{ij}}{1-k}\ ;\ k = \frac{\left\lvert \sum_{i=1}^{n} X_i - \sum_{i=1}^{n} M_i \right\rvert}{\sum_{i=1}^{n}(X_i + M_i)}$
Aquino (1978)	$AQ_{ij} = \left[\frac{\sum_{i=1}^{n}(X_{ij} + M_{ij}) - \sum_{i=1}^{n}\lvert \hat{X}_{ij} - \hat{M}_{ij}\rvert}{\sum_{i=1}^{n}(X_{ij} + M_{ij})}\right] \times 100\ ;$ $\hat{X}_{ij} = X_{ij} \cdot \frac{1}{2}\frac{\sum_{i=1}^{n}(X_{ij} + M_{ij})}{\sum_{i=1}^{n} X_{ij}}$ and $\hat{M}_{ij} = M_{ij} \cdot \frac{1}{2}\frac{\sum_{i=1}^{n}(X_{ij} + M_{ij})}{\sum_{i=1}^{n} M_{ij}}$
Vona (1991)	$IIT^{i}_{A,B} = X^{i}_{A,B} + M^{i}_{A,B} \rangle 0$ if each of $X^{i}_{A,B}$ and $M^{i}_{A,B} \rangle 0$ $IIT^{i}_{A,B} = 0$ if either of $X^{i}_{A,B}$ or $M^{i}_{A,B}$ is zero $VN_{ij} = \frac{\sum_{i=1}^{n} IIT^{i}_{A,B}}{X^{j}_{A,B} + M^{j}_{A,B}} \times 100\ ,\ \forall i$ when $IIT^{i}_{A,B} \rangle 0$
Brullhart (1994)	$MIIT_{ij} = \left[1 - \frac{\lvert (X_t - X_{t-k}) - (M_t - M_{t-k}) \rvert}{\lvert X_t - X_{t-k} \rvert + \lvert M_t - M_{t-k} \rvert}\right] \times 100$

Note: Notations have their standard meanings. Only, B_{ij} range from 0 to 1 and has an opposite sign effect. All other indices range from 0 to 100.

Table A.2: Variables, Definitions and Sources

Variables	Definitions	Sources
Dependent Variable Magnitude of IIT, *l*-VIIT, *h*-VIIT and H-IIT	Average Magnitude of GL_{ij} of the i^{th} industry at the HS-6 digit level	UN Comtrade
Independent Variables Product Share at the HS- 6 Digit Level		UN Comtrade
IIT	$\left(\frac{\text{No. of Products Engaged in IIT}}{\text{Total No. of Products in Total Trade}}\right)_i \times 100$	
l-VIIT	$\left(\frac{\text{No. of Products Engaged in } l\text{ - VIIT}}{\text{Total No. of Products in V - IIT}}\right)_i \times 100$	
h-VIIT	$\left(\frac{\text{No. of Products Engaged in } h\text{ - VIIT}}{\text{Total No. of Products in V - IIT}}\right)_i \times 100$	
H-IIT	$\left(\frac{\text{No. of Products Engaged in H - IIT}}{\text{Total No. of Products in Total IIT}}\right)_i \times 100$	
Trade Share of the i^{th} industry	$\frac{(X+M)_i}{\sum_{i=1}^{22}(X_i+M_i)} \times 100$	UN Comtrade
RCA at the HS- 6 Digit Level	a. No. of Products engaged in IIT, *l*-VIIT, *h*-VIIT and H-IIT having a RCA	UN Comtrade
	b. Share of products engaged IIT, *l*-VIIT, *h*-VIIT and H-IIT having a RCA	
(b.1) IIT	$\left(\frac{\text{No. of Products Engaged in IIT having RCA}}{\text{No. of Products Engaged in IIT}}\right)_i \times 100$	
(b.2) *l*-VIIT	$\left(\frac{\text{No. of Products Engaged in } l\text{ - VIIT With RCA}}{\text{No. of Products Engaged in } l\text{ - VIIT}}\right)_i \times 100$	
(b.3) *h*-VIIT	$\left(\frac{\text{No. of Products Engaged in } h\text{ - VIIT With RCA}}{\text{No. of Products Engaged in } h\text{ - VIIT}}\right)_i \times 100$	
(b.4) H-IIT	$\left(\frac{\text{No. of Products Engaged in H - IIT With RCA}}{\text{No. of Products Engaged in H - IIT}}\right)_i \times 100$	
Net Exports	$(X-M)_i$	UN Comtrade
Total Anti-dumping Initiations	Anti-dumping Initiations *initiated* by i^{th} industry + Anti-dumping Initiations *faced* by the i^{th} industry	Global Antidumping Database

Table A.3: Pesaran (2007) Panel Unit Root Test in the Presence of Cross-Sectional Dependence

Variables	CIPS test statistic	Result
Magnitude of IIT	–2.765[c]	Stationary at Level
Magnitude of *l*-VIIT	–2.968[b]	Stationary at Level
Magnitude of *h*-VIIT	–3.388[a]	Stationary at Level
Logit Transformation Magnitude of *h*-VIIT	–3.669[a]	Stationary at Level
Magnitude of H-IIT	–4.630[a]	Stationary at Level
Logit Transformation Magnitude of H-IIT	–4.617[a]	Stationary at Level
IIT Product Share	–2.823[b]	Stationary at Level
l-VIIT Product Share	–3.406[a]	Stationary at Level
h-VIIT Product Share	–3.355[a]	Stationary at Level
No. of Products RCA IIT	–3.213[b]	Stationary at Level
No. of Products RCA *l*-VIIT	–2.917[c]	Stationary at Level
No. of Products RCA *h*-VIIT	–3.5[a]	Stationary at Level
No. of Products RCA H-IIT	–5.148[a]	Stationary at Level
Share of Products RCA IIT	–3.759[a]	Stationary at Level
Share of Products RCA *l*-VIIT	–2.686	*Non-Stationary at Level*
Log (Share of Products RCA *l*-VIIT)	–2.899[b]	Stationary at Level
Share of Products RCA *h*-VIIT	–4.871[a]	Stationary at Level
Share of Products RCA H-IIT	–4.938[a]	Stationary at Level
Net Exports	–2.962[b]	Stationary at Level
Trade Share	–3.240[a]	Stationary at Level
Total Anti-dumping Initiations	–4.307[a]	Stationary at Level

Note: *a*, *b* and *c* denote statistical significance at 1%, 5% and 10% level. *a* = – 3.3; *b* = – 2.94; *c* = – 2.76

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End Notes

[1]During the end of last decade, India traded twelve times more to what it traded in 1990, and during 2001-08 India’s foreign trade grew on an average of around 28%.

[2]For instance, India’s share increased from 0.58% in 1990 to 0.71% in 2000. It is only in the periods after 2010 that India’s share was at around 2%. However, the growth rate of India’s share in world trade during the period 2002 – 11 was around 11% making it highest among the sample period.

[3]For instance, empirical studies on Australia, India, Spain, and other cross-country comparisons have shown that trade reforms have a positive impact on the magnitude of total IIT; see, Balassa & Bauwens (1987), Veeramani (2002, 2004, 2009),Sharma (2004), Baleix & Egido (2010), Ito & Okubo (2011).

[4] The author cites couple of reasons for the rise of such trade. First, India’s growing GNP with a wide income gap give rise to country’s demand for varieties of the same product. Second, the co-existence of both traditional and modern methods of production in the country give way to both traditional and modern methods of production of different qualities of the same product.

[5] In the facet of import competition, firms compete by specializing and producing a subset of varieties within an industry so as to exploit internal scale economies such as to reduce adjustment cost; Brullhart & Thorpe (2000).

[6]One can find that Bhattacharyya (1991) computed some of the indices used in this paper that too at the SITC- 2 &3 digit classification level for the period 1970-87. On the other hand, Veeramani (2002, 2004 and 2007) in his studies computed the magnitude of India’s IIT using only one index at the HS- 4 digit level for some specific years. Burange and Chaddha (2008) concentrated only on two indices at the HS- 4 digit classification level.

[7]Both GL_{ij} and GLC_{ij} would have *downward* and *upward* bias, respectively for their measurements of IIT. GL_{ij} would have a *downward* bias because trade imbalance is associated with each commodity. GLC_{ij} would be *upward* biased since each commodity (or industry) does not have equiproportional trade imbalance

[8] Theoretically, Aquino (1978) finds his index to be exactly equal to the index of Michaely (1962).

[9]The idea behind considering the many dispersion factors is to cater the presence of transport and freight cost, exchange rate differences, among others and check for the sensitivity of results.

[10]Here in this paper along with considering the lower threshold value of $1-\alpha$ proposed by Greenaway *et al*. (1994) we also use $1/(1+\alpha)$ as proposed by Fontagne & Freudenberg (1997). For a detailed explanation on the latter’s formulation, see Fontagne & Freudenberg (1997).

[11]For the sake of space saving, our paper reports only the periodic average magnitude of IIT calculated using the static indices. The full results incorporating all the years across all the stated classification levels can be obtained upon request to the authors.

[12]The average size of the bias at HS- 2, 4 & 6 digit classification levels for GL_{ij} and GLC_{ij} are 6.86,–1.64, 1.47 and –7.81, –13.69,–13.84, respectively.

[13]Again due to space limitations, we only depict the average values of GL_{ij} over time period for the 21 broad commodity sections. Results considering all these commodity sections at the said HS classification levels can be acquired on request to authors.

[14]We drop out miscellaneous manufacturers from the list of common entries. This is because one is not sure of the type of product that forms the industry.

[15] Again we find the aggregation effect. As one moves to a higher classification level there is a fall in the magnitude of IIT values but the pattern of it remain same.

[16]Over the period 1990-2013, at the HS- 6 digit level industry of Stone, Cement & Glass had around 90% of its commodity groups engaged in IIT while industry of transport equipment had it around 77%.

[17]In the paper we report only the values obtained using Greenaway *et al*. (1994) measure at $\alpha = 0.15$. We also check the sensitivity of our results by considering α at 10%, 25% and 35% and the Fontagne & Freudenberg (1997) technique. In all such cases our results did not change qualitatively from that reported.

[18]The i^{th} commodity group is considered to have a RCA if $\dfrac{X_i^{\text{Home}} \Big/ \sum_i X_i^{\text{Home}}}{X_i^{\text{World}} \Big/ \sum_i X_i^{\text{World}}} > 1$.

[19] Cross-sectional dependence or the cross-section correlation of errors could arise out of omitted common effects, spatial effects. Such kind of errors are increasing since, economic integration of countries imply strong interdependency between cross-sectional units; see, Hoyos and Sarafidis (2006) for details.

[20] Pesaran (2007) proxies the unobserved common factor f_i with the cross-sectional mean of Δy_{it} and y_{it-1} in the Dickey-Fuller equation.

[21] Following extant empirical literature on intra-industry trade, the dependent variable in our study is a logit transformed one (i.e., $\ln\left(\dfrac{y_{it}}{100 - y_{it}}\right)$). This is done to relax the criterion that the predicted value of the dependent variable must also lie within the interval [0,100].

[22] The average growth rate for share of products engaged in *low* vertical IIT has been around 1.28% while for high vertical and horizontal IIT it is around 16% and 13%, respectively.

[23] Our result also indicates that anti-dumping initiations made by Indian firms are not being sufficient for them to leapfrog the foreign firm’s technologically superior good.