

## Static and dynamic analysis of intra-industry trade of BRICS countries

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**Abstract.** *In this article, we tried to estimate Intra-Industry Trade among the BRICS countries. IIT calculated by employing Grubel and Lloyd IIT Index for static analysis and Thom and McDowell (1999) MIIT index for dynamic analysis. Additionally, the decomposition of IIT carried out to distinguish between Horizontal and Vertical IIT. The unit of analysis selected at one-digit and two-digit SITC Industry level for GL IIT index, Further, to conduct MIIT analysis, industry is defined at two-digit-SITC level data by aggregating four-digit SITC sub-industry level data of IIT of BRICS countries. Further, study analysed the Pre and Post-BRICS trade pattern of IIT. Therefore, this study emphasises that do emerging economies IIT among themselves? On the basis of estimated results of this study revealed that IIT occurs at higher level of aggregation. This signifies that developing countries are trading in the same Industry for love for variety and cost effectiveness. Hence, the empirical result contradicts conventional Krugman (1979, 1985) hypothesis of IIT trade takes place in developed nations (industrialist nations). This implies that BRICS countries should focus on opportunities of trade complementary of intermediates products. This will enhance cost effectiveness of product development or production. Further, this will promote innovation in the BRICS region. To achieve this, countries needs to conduct constructive trade dialog among the BRICS countries.*

**Keywords:** intra industry trade, marginal intra industry trade, Grubel and Lloyd index, Thom and McDowell index, BRICS.

**JEL Classification:** F1, F11, F15.

## Introduction

Conventionally, trade takes place between the nations on the basis of comparative advantage of a nation until 1960 e.g. Adam (1776), Ricardo (1817), Heckscher (1919) and Ohlin (1933). From 1960s, pattern of trade has changed. This has been nicely observed by Grubel and Lloyd (1971). In that paper, it is argued that trade takes place between nations in similar industry. The shadow has been cleared on this finding by consecutive papers by Krugman (1979, 1980), Helpman (1981) and Krugman and Helpman (1985) where clearly argued that trade takes place on the basis of product differentiation, love for variety, economies of scale, and increasing returns. The market structure is imperfect competition. The structure of trade is intra industry or two way trade in same industry between the nations. Further, this phenomenon was observed in developed nation, where factor endowment, income level (i.e. per capita income) and geographical conditions are similar. Nonetheless, this was not true for the developing countries and the least developed countries.

In general, IIT performance measured by Grubel and Lloyd (1971) index for a year. Where, it shows changes in trade flow in each period. Nonetheless, marginal intra-industry trade (MIIT) index reveals changes in trade flow of IIT over/between the period(s). In addition, MIIT is related to adjustment cost, which is indirectly related to trade liberalization and reallocation of resources. The reallocation of resources happen between industries (IT: inter industry) as well as within industry (IIT). It also covers structural adjustment cost. In literature, number of studies covered adjustment cost and employment relationship discussion. However, these issues will not discuss in details in the present study. Here, the article will focus on IIT and MIIT in reference to BRICS countries. Additionally, adjustment cost also reveals disequilibrium phenomena; it is related to structure change in trade flow (exports and imports).

Further, IIT can be distinct into two parts such as horizontal (HIIT) and vertical IIT (VIIT). HIIT defined as economies of scale where products are differentiated and consumers choose products for product variety. Conversely, VIIT defined at the industry level, where production process of goods is vertically integrated, whereas firms are situated in trading partner's countries and trade takes place on the basis of specialization (comparative advantage) as illustrated in inter-industry trade (IT). For instance, a component is produced in one nation and processed in another and the finished good could be exported again, either as final good or intermediate goods. Moreover, a computer processor produced in one nation and exported to nation two, where computer is assembled and produced final good as computer that can be exported to nation one.

BRICS Acronyms made from Brazil, Russia, India, China and South Africa. Initially, BRIC term coined by O'Neill (2001), where, a comparison has been made between G7 countries and BRIC countries. This was all about future leading economies in 2050. The finding of the study suggested that the largest economy in the world would be China followed by United States of America, India, Japan and Brazil. Consequently, it gave the voice to forming the BRIC as a group. The term BRIC becomes BRICS after the inclusion of South Africa in 2010, when 2<sup>nd</sup> BRICS summit held in Brazil. Overall, BRICS accounts for 24% of the global GDP in nominal terms and in absolute figure

stands for \$20.3 trillion GDP. The population size is 3.6 billion by the World Bank database. Further, the IIT among BRICS countries stands for \$33.8 billion in 2001. In 2010, IIT was \$414 billion, which increased to \$675.3 billion in 2018 as per two-digit-SITC level data, UNCOMTRADE database, 2020.

Furthermore, in this article, we tried to shed light on intra industry trade (IIT) among developing nations such as BRICS countries, where, two-way trade analysis has been carried out for the BRICS nations. The purpose of the study is to trace the evidence on IIT among the BRICS countries. Further, to reach the purpose of the study, we setup followings question: whether BRICS economies trade among themselves in the same industry or not? If so, what level of aggregation of data (industry)? To search the answer of these basic questions, we applied Grubel and Lloyd (1971) IIT index and marginal intra-industry trade index as proposed by Thom and McDowell (1999). In addition, we also distinguished IIT between horizontal and vertical IIT.

The few study tried to analyse IIT with respect to BRICS countries. For example, Proença and Faustino (2015), Filipowicz (2016), Şahbudak and Şahin (2016), Maxir and Masullo (2017), Mutambara (2017) and Cattaneo and Snowball (2019), Aditya and Gupta (2019) tried to analyse IIT by GHM method with gravity model setup. On the hand, Dwesar and Kesharwani (2019) and Varshini and Manonmani (2019) tried to apply GLI and MIIT index. Further, Lohani (2020) analysed trade flow of BRICS countries using gravity model and found trade creation such implies that nearly 20% of exports are above the normal level in the bloc since inception of BRICS bloc. In addition, Kubendran (2020) also applied gravity model of trade for BRICS countries. However, did not focus on IIT. Thus, present study tried to fill the gap and present study prompts.

This organisation of the paper is in followings sequence i.e. Introduction, Review of Literature, Methodology, Results; Discussion and Conclusion and Policy Implications.

## Review of literature

Traditionally, trade takes place on basis of comparative advantage. This was argued by classical economist i.e. Adam (1776), Ricardo (1817), etc. Thereafter, neoclassical economist said trade takes place on the basis of factor abundance and specialisation i.e. Heckscher (1919) and Ohlin (1933). Finally, new trade theorist said trade takes place on account of product differentiation, love for variety, consumer preference, economies of scale and increasing returns to scale in the same industry i.e. Krugman (1979, 1980), Eaton and Kierzkowski (1984), Kierzkowski (1989). To verify this argument, next sub-sections will discuss recent empirical studies related to IIT. Further, Balassa (1979), Falvey and Kierzkowski (1987) argued that economies with less trade barriers have larger levels of IIT.

## Static intra-industry trade

The first attempt to analyse the IIT has been made by Grubel and Lloyd (1971) analysed intra-industry trade at three digit SITC level of aggregation of data of nine OECD

member countries. The empirical evidence revealed that IIT taking place below the three digits SITC level of aggregation between Australia and other OECD countries. IIT mainly taking place in primary goods or processed manufacture goods. Further, Casson and Pearce (1988) discussed intra-firm trade and its four factors i.e. propensity to: circulate, trade, internalise, and the composition of final output that affect intra-firm trade and related to horizontal product differentiation as well. In addition, multinational enterprise may exploit opportunities by horizontal differentiation of products. For instance, Japanese production would have benefited and developing nations as well. This leads to intermediate products inflowing into intra-firm trade and developing countries surely going to gain from it. Furthermore, Islam (2018) analysed Bangladesh and India trade flow by using RCA and GLI for inter-industry trade and IIT respectively at HS two digit level of disaggregation. The results showed that India has comparative advantage in more than 10 products whereas Bangladesh has comparative advantage in 8 products exports. IIT is in mostly in oil/mineral fuels and cotton industry and the magnitude was very low i.e. 16% and 4% respectively. Boyrie and Kreinin (2011) estimated GLI for IIT and analysis was concentrated on inter-industry trade of manufacturing products from five to eight digits SITC level data, and then aggregated in the four digit classification. Further, the analysis carried out at nation's total trade and bilateral trade as well. The estimated results illustrate that IIT is huge among OECD nations, whereas IIT largely taking place from North to South and South to South region.

### Dynamic intra-industry trade

The pioneer attempt has been made by Brulhart (1994), tried to analyse dynamic approach of GLI, which is considered as static method to analyse IIT. This study proposed MIIT (marginal IIT) index to examine trade flow including adjustment costs. Another limitation of GLI was that the dynamic adjustment factors including the sectoral and geographical distribution benefit could not able to capture. Further, the Irish chemicals sector was analysed between 1985 and 1990 period. The study concluded that single indicator is not enough to state all crucial information; hence, a multi-stage evaluation may be the only practicable way out. Further, Thom and McDowell (1999) estimated marginal intra-industry trade (MIIT) in light of trade liberalisation and structural adjustment costs. Where, point out that the Brulhart (1994) MIIT index was able to measure only horizontal IIT, which lead to overestimation of adjustment cost, thus, study introduced new measure of MIIT such as dynamic MIIT by combining of Brulhart's index and the aggregate index as suggested in that study. Consequently, VIIT is the difference of two measures i.e. residual of two indices. This was estimated for the trade flows between the EU and three Central and Eastern Europe countries. Further, the study suggested that if we avoid the distinction between vertical IIT and inter industry trade leads to risk of underestimating the level of IIT and, *ceteris paribus*. Another study by Al-Mawali (2006) examined country-specific factors of VIIT and HIIT in South Africa employing the panel gravity model of trade. Three types of econometric model have been applied. Conventional assumptions of the gravity model and IIT have been found true in case of South Africa. However, geographical distance is inversely related to

IIT. Further, Jing (2009) analysed data on HS two digit up to 24 chapters related to agriculture trade of China. The indices were computed such as GLI, Brühlhart marginal IIT index, and Thom and McDowell marginal IIT index during 1996-2005. Results were found that agricultural IIT is considerably low, and Brühlhart index shown that IIT improving over the decades, Thom and McDowell index revealed that gain from trade was mostly coming from growth of VIIT.

### Studies on BRICS bloc

Proença and Faustino (2015) examined IIT including HIIT and VIIT with respect to Portugal and the BRIC countries, the European Union, and the five Portuguese-speaking African countries. Further, the semi parametric gravity model methods have been applied to control for unobserved heterogeneity. The sample size consists 38 countries and for the period of 1995-2006. The outcome of empirical model showed that misspecification assumption of the parametric model has been corrected by the present approach. IIT has been adversely affected by distance and the effect of economic integration on IIT found inconclusive. BRIC economies trade in similar quality of goods. Additionally, IIT is inversely affected by GDP per capita difference between the trading partners. Further, Filipowicz (2016) analysed the Russian Federation RTAs with reference to global value chains (GVCs). This study covered India, China, South Africa, Mexico and Russia Federation and concluded that favourable RTA must be decided by structure of GVCs of respective country. Furthermore, Şahbudak and Şahin (2016) analysed IIT in agriculture products between China and Brazil during 2000-2014. In order to analyse IIT, Grubel-Lloyd Index (GLI), HIIT and VIIT have been computed at SITC three digit level of aggregation. The study revealed that IIT in agriculture product is very low and low quality of VIIT taking place between China and Brazil. Moreover, Maxir and Masullo (2017) examined Brazil's trade in forest products for the period of 2000-2014. The RCA and GL indices have been measured to determine IIT and IT. The results found that Brazil has comparative advantage (CA) in fuel wood, wood panels, wood floors, wood articles and wood pulp and imports very low volume of wood and paper. Another study by Mutambara (2017) examined South Africa's trade relations with conventional trading partners and with China as well. The methods were used such as the factor intensities of goods traded, trade intensity with each country, ease of market access of its products, and IIT opportunities during 2001-2015. Results infer that China is top trading partner of South Africa. South Africa's trade with China is purely complimentary in comparison to conventional trading partners. China is a market mostly for non-fuel primary commodities for South Africa, whereas the conventional trade partners gives markets for both low value and high value added products and further scope for IIT to South Africa. In addition, South Africa conventional comparative advantages are in low value added products primary commodities such as non fuel primary commodities and minerals and mineral fuels. In addition, Cattaneo and Snowball (2019) analysed trade in cultural and creative industries of South Africa with BRICS countries and results found that South Africa has trade deficit in cultural good with China and India during 2008-2016. On the other hand, South Africa trade in cultural goods with Russia shows surplus. Moreover,

crafts and audio-visual sectors are reducing significant trade deficit. Further, study suggested that trade preferences favoured SADC, the EU and EFTA above BRICS partners. Further, Dwesar and Kesharwani (2019) examined the magnitude of IIT between India and China using Brühlhart weighted marginal IIT A-Index during 1999-2018. Further, the study covered data on HS two digit i.e. 99 commodities and compared decade-wise IIT performance. The evidence was found that India exports to China raw-materials and some semi-finished goods. While China's exports to India primary products and secondary manufactured goods. Percentage share of IIT in total trade are ranging from 10% to 20% over the years. Lastly, Varshini and Manonmani (2019) analysed trade advantage of Indian pharmaceutical industry 2000-2014. The methods were used i.e. Marginal Intra-Industry Trade, Horizontal and Vertical Intra-industry, Balassa Revealed Comparative Advantage (RCA), Revealed Symmetric Comparative Advantage, Normalized RCA, and Vollrath's Trade Advantage indices were estimated. The empirical results revealed that intra-industry trade taking place at the higher level. However, comparative disadvantage has been observed for this industry. In addition, India exports high quality of pharmaceutical products to the world.

#### Other methods

Caporale et al. (2015) analysed Chinese trade flows and trade specialisation using gravity model of trade from 1992-2012. The analysis consists major trading partners from Asia, Europe and North America and fixed effect vector decomposition model has been used to estimate gravity model. The empirical results revealed that there is a change in structure of foreign trade of China specifically to paradigm shift from resource – and labour-intensive to capital – and technology-intensive exports has been observed. Further, in addition, Konno (2016) estimated inter industry trade and IIT including HIIT and VIIT for Russian trade flow with major trading partners. Thereafter, determinants of IIT have been analysed by using log- linear gravity model of trade for the period of 2000-2013. The feasible generalised least square, fixed effect and random effect econometric model have been estimated. The results were found that conventional assumptions of gravity model are valid for Russia. In addition, FTA, FDI and Commonwealth Independent States/Customs Union membership positively influencing trade of Russia. Nonetheless, distance is adversely affecting trade flow. Furthermore, Marzábal et al. (2016) analysed performance of IIT between EU and Latin America with reference to Brazil and Mexico and studied the factors affecting trade and foreign direct investment. Study also focused on input-output framework. In addition, Mhaka and Jeke (2018) analysed trade performance between South Africa and China during 1995-2014. The OLS method has been used to analyse bilateral trade flow, economic size, population or market size, and exchange rate of respective countries. The result showed that economic size positively affecting trade whereas exchange rate is inversely related to trade flow. Aditya and Gupta (2019) examined India's IIT specifically to decomposition of IIT into horizontal and vertical trade. It analysed by using Greenaway-Hine-Milner and support vector machines method. The results of both the method have been compared and contrasted during 1978-2013 at SITC 5 digit level of data aggregation. The results showed that India's trade

is horizontal IIT. However, vertical IIT are increasing in comparison to horizontal IIT over the period. In addition, the industry wise analysis namely bakery industry, phosphorus industry, aluminium industry results revealed that is horizontal IIT. Chin et al. (2019) computed IIT decomposing into HIIT and VIIT and analysed VIIT and economic size for the Malaysian economy for the period of 1988-2016. The study covered Malaysia's trade with its top trading partners and panel vector autoregression method used for data analysis. The results revealed that positive bidirectional causality relationship exist between VIIT and economic size and trade-led growth hypothesis is valid in case of Malaysia. Lastly, Brodzicki et al. (2020) examined factors affecting VIIT and HIIT of Spain and Poland employing gravity model of trade estimated by fixed effect and PPML models from 2005-2014. The factors were included such as convention factors of standard gravity model of trade including various indicators of trade cost, regional factors and FDI. The study formulated hypothesis based on economic theory and most of them found true and some them were false.

The purpose of this study is to know the BRICS bloc formation effect on IIT of BRICS countries. However, after reviewing the literature, we did not find ample of evidence on IIT and MIIT analysis specific to IIT of BRICS countries. Very few study tried to analyse IIT with respect to BRICS countries. For example, Proença and Faustino (2015), Filipowicz (2016), Şahbudak and Şahin (2016), Maxir and Masullo (2017), Mutambara (2017) and Cattaneo and Snowball (2019) tried to analyse IIT with gravity model setup and GHM method. On the other hand, Aditya and Gupta (2019), Dwesar and Kesharwani (2019) and Varshini and Manonmani (2019) tried to apply GLI and MIIT index. Thus, present study tried to fill the gap and present study prompts. The next section will elaborate on methodology of this study.

## Methodology

The Intra Industry Trade is measured by following methods: The pioneer attempt made by Grubel and Llyod (1971) to measure IIT. Thus, it usually known as Grubel and Llyod Index (hereinafter referred to as GLI). The GLI is calculated by:

$$GLI_x = 1 - \frac{|E_x - M_x|}{(E_x + M_x)} \quad (1)$$

Where, E stands for export of x country to y country in the similar industry and M stands for import of x country from y country in the similar industry. Subscript x and y is country name. The index values remain within zero and one or  $0 \leq GLI \leq 1$ . The index explains that if  $GLI = 1$ , it implies that country's IIT is very high with respect to trading partner. Conversely, if  $GLI = 0$ , this implies that country's trade in the inter industry only. The other classification of values of GLI is following: if  $GLI \geq .25$ , it infers that IIT is low, if  $.25 \leq GLI \leq .5$  it implies that IIT is in lower level; further, when, GLI values lies between .75 and 1 or  $.75 \leq GLI \leq 1$ , this reveals that IIT is high in the trade flow.

Marginal Intra Industry Trade index (MIITI): This is measured by Brulhart (1994). The MIITI uses to analyse the dynamic aspects of IIT. Whereas, GLI was unable to captured

and considered as static analysis. Nonetheless, Brulhart (1994) was able to calculate only HIIT or IIT in similar products in the same industry. Therefore, this study uses Thomand and McDowell (1999) approach because it is more comprehensive. Additionally, this approach uses aggregate of all sub-IIT and present IIT at industry level. Further, also, able to differentiate IIT between HIIT and VIIT at industry level. The definition of VIIT and HIIT defers from GHM approach. In this case, trade in different sub sector in the same industry or sector called as VIIT e.g. trade in computer and computer parts or assembly and trade in similar product of the same sector or industry defined as HIIT. Furthermore, inter industry is calculated as residual form total trade. The equation (3) illustrate Briilhart (1994) unweighted MIITI for 's' industry. To measure MIIT at sub sector, equation (4) formed as suggested by Briilhart (1994), where  $A_w$  denotes weighted MIITI for 's' industry;  $W$  denotes a weight that is calculated by

$$A_s = 1 - \frac{|\Delta E_s - \Delta M_s|}{|\Delta E_s| + |\Delta M_s|} \quad (3)$$

$A_s$  value lies between zero and one, where,  $A_s = 0$  implies that pure inter-industry trade (IT) and  $A_s = 1$  refers to high degree of IIT. If the values of  $A_s$  remain between 0 and .5 or  $0 \leq MIITI \leq .5$ , this implies that MIIT at high level.

$$A_w = \sum_{i=1}^N W_r A_r \quad (4)$$

The equation (4) is weighted MIITI and calculated at sub-industry level and aggregate sub industry's calculated value by multiplying weighted value to get equation (4) give aggregate MIITI at industry level.

$$W_s = \frac{|\Delta E_s| + |\Delta M_s|}{\sum_{i=1}^N (|\Delta E_i| + |\Delta M_i|)} \quad (5)$$

To estimate Thomand and McDowell (1999) aggregate approach, the equation (6) would be estimated. The equation (6) also written as equation (7). Furthermore, to decompose total trade flow, the differentiation of IIT have been done by computing  $A_w$ , it reveal IIT then computing  $(A_s - A_w)$  denotes VIIT and finally, to get IT  $(1 - A_s)$ .

$$A_s = 1 - \frac{|\Delta E_s - \Delta M_s|}{\sum_{i=1}^N (|\Delta E_i| + |\Delta M_i|)} \quad (6)$$

$$A_i = 1 - \frac{|\Delta E_s - \Delta M_s|}{|\Delta E_s| + |\Delta M_s|} \quad (7)$$

Eq. 7 is weight index suggested by Briilhart (1994) for  $A_s$ . MIITI measures the trade direction and structure of changes between distinct time periods. In other words, it measures the gap between change in total export and import and change in net trade. This also captures the adjustment process of IIT. This was not possible to trace by GLI method. Further, When,  $A_s$  reveals positive value and closer to one, implies that sectoral trade is converging trend and shows predominance of MIIT in the adjustment process. Nonetheless, if  $A_s$  shows negative value, this implies that divergence trend in sectoral trade flows, while other thing remaining constant, leads to greater transitional adjustment costs. The next section will describe results of the study.

## Empirical results

### *Static IIT analysis*

The GLI results of BRICS countries are presented in Tables 1-6 on one digit-SITC level data and Tables 7-9, reports GLI results for the year 2001, 2010 and 2018 at two-digit SITC level data. The year 2001 depicts pre-BRICS scenario, year 2010 shows at the time of BRICS formation level of IIT prevailing among the BRICS countries and year 2018 reveals post-BRICS IIT performance. Further, Brazil's IIT with BRICS countries are in followings sectors: IIT with China is at low level only in [6] manufacture goods over the period; IIT with India is at low level in [6] manufacture goods and [7] Machinery and transport equipment; IIT with Russia is low in [2] Crude materials, inedible, except fuels, and [8] miscellaneous manufactured articles; and IIT with South Africa is high in [1] Beverages and tobacco, [2] Crude materials, inedible, except fuels, [3] Mineral fuels, lubricants and related materials, [5] Chemicals and related products, n.e.s., and [6] Manufactured goods. Overall, Brazil's IIT takes place with BRICS countries mostly in [6] manufacture goods and [3] Crude materials, inedible, except fuels (Table 1).

**Table 1.** *Brazil's IIT with BRICS Countries at SITC-One Digit Data Level*

BRAZIL PRODUCT	CHINA			INDIA			RUSSIA			SOUTH AFRICA		
	2001	2010	2018	2001	2010	2018	2001	2010	2018	2001	2010	2018
ALL	0.82	0.91	0.70	0.69	0.90	0.97	0.59	0.63	0.66	0.81	0.73	0.65
0	0.50	0.64	0.21	0.23	0.03	0.12	0.03	0.00	0.04	0.07	0.02	0.02
1	0.00	0.00	0.04	NA	0.09	0.20	0.01	0.01	0.03	0.24	0.25	0.52
2	0.02	0.01	0.01	0.14	0.16	0.18	0.15	0.74	0.47	0.60	0.64	0.93
3	0.48	0.10	0.04	0.00	0.80	0.17	0.00	NA	0.00	1.00	0.12	0.94
4	0.03	0.00	0.02	0.00	0.29	0.08	NA	NA	NA	0.00	0.01	0.06
5	0.25	0.25	0.20	0.21	0.34	0.29	0.04	0.04	0.03	0.75	0.69	0.60
6	0.85	0.43	0.51	0.72	0.54	0.34	0.14	0.12	0.23	0.48	0.63	0.85
7	0.74	0.10	0.04	0.86	0.55	0.55	0.78	0.45	0.12	0.13	0.32	0.09
8	0.06	0.02	0.03	0.83	0.26	0.26	0.09	0.95	0.25	0.18	0.27	0.32
9	NA	0.00	0.00	NA	NA	NA	NA	NA	0.00	NA	0.75	NA

**Source:** Author own calculation based on UNCTAD database accessed on 02/02/2020.

**Table 2.** *China's IIT with BRICS Countries at SITC-One Digit Data Level*

CHINA PRODUCT	BRAZIL			INDIA			RUSSIA			SOUTH AFRICA		
	2001	2010	2018	2001	2010	2018	2001	2010	2018	2001	2010	2018
ALL	0.73	0.78	0.58	0.95	0.68	0.42	0.51	0.93	0.86	0.94	0.84	0.71
0	0.55	0.55	0.29	0.42	0.70	0.92	0.52	1.00	0.97	0.81	0.59	0.87
1	0.00	0.01	0.03	0.17	0.12	0.50	0.01	0.17	0.63	0.06	0.92	0.43
2	0.01	0.01	0.01	0.51	0.07	0.27	0.08	0.05	0.05	0.10	0.03	0.02
3	0.00	0.14	0.05	0.25	0.87	0.53	0.12	0.03	0.01	0.53	0.27	0.90
4	0.12	0.00	0.02	0.22	0.03	0.03	0.57	NA	0.04	0.46	0.30	0.33
5	0.56	0.37	0.28	0.80	0.30	0.36	0.14	0.71	0.82	0.99	0.54	0.39
6	0.86	0.48	0.74	0.85	0.54	0.80	0.26	0.73	0.80	0.86	0.71	0.61
7	0.63	0.11	0.22	0.28	0.08	0.09	0.22	0.06	0.09	0.38	0.05	0.02
8	0.11	0.02	0.02	0.51	0.18	0.14	0.17	0.01	0.03	0.02	0.02	0.03
9	NA	0.01	0.00	0.16	0.46	NA	0.00	0.65	NA	0.01	0.00	NA

**Source:** Author own calculation based on UNCTAD database accessed on 02/02/2020.

**Table 3.** India's IIT with BRICS Countries at SITC-One Digit Data Level

INDIA PRODUCT	BRAZIL			CHINA			RUSSIA			SOUTH AFRICA		
	2001	2010	2018	2001	2010	2018	2001	2010	2018	2001	2010	2018
ALL	0.80	0.98	0.89	0.57	0.58	0.35	0.98	0.46	0.47	0.46	0.82	0.82
0	0.42	0.03	0.10	0.51	0.65	0.44	0.01	0.09	0.25	0.22	0.14	0.45
1	0.02	0.17	0.15	0.12	0.29	0.82	0.00	0.00	0.04	0.30	0.03	0.43
2	0.13	0.14	0.15	0.95	0.11	0.50	0.32	0.23	0.43	0.21	0.12	0.05
3	0.05	0.86	0.19	0.01	0.79	0.56	0.01	0.01	0.01	0.00	0.78	0.34
4	0.02	0.21	0.06	0.17	0.05	0.09	0.00	0.35	0.81	0.51	0.37	0.02
5	0.33	0.45	0.36	0.63	0.30	0.44	0.98	0.49	0.95	0.42	0.66	0.33
6	0.89	0.61	0.42	0.56	0.79	0.42	0.48	0.20	0.22	0.88	0.70	0.99
7	0.62	0.63	0.50	0.12	0.05	0.07	0.28	0.89	0.78	0.90	0.09	0.20
8	0.92	0.28	0.26	0.38	0.13	0.15	0.36	0.28	0.81	0.11	0.06	0.17
9	0.60	0.10	0.00	0.91	0.02	0.01	0.07	0.12	0.00	0.02	0.01	0.00

**Source:** Author own calculation based on UNCTAD database accessed on 02/02/2020.

China's IIT with BRICS countries are in sectors such as IIT with Brazil is at high level only in [6] manufacture goods and in the low level in [0] Food and live animals and [5] Chemicals and related products, n.e.s. over the period; IIT with India is in high level in [6] manufacture goods and at low level in [0] Food and live animals [5] Chemicals and related products, n.e.s.; IIT with Russia is high level in [0] Food and live animals, [6] manufacture goods and [5] Chemicals and related products, n.e.s. and at low level in [1] Beverages and tobacco over the period; and IIT with South Africa is high in [0] Food and live animals and [3] Mineral fuels, lubricants and related materials, and at low level in [1] Beverages and tobacco, [4] Animal and vegetable oils, fats and waxes, [5] Chemicals and related products, n.e.s., and [6] Manufactured goods. Overall, China IIT does with BRICS countries mostly in [6] manufacture goods and [5] Chemicals and related products, n.e.s. (Table 2).

Further, India's IIT with BRICS countries are in sectors like: IIT with Brazil is at low level only in [7] Machinery and transport equipment and at the lowest level in [5] Chemicals and related products, n.e.s., [6] manufacture goods and [8] Miscellaneous manufactured articles over the period; IIT with China is at high level in [1] Beverages and tobacco and at low level [2] Crude materials, inedible, except fuels, [3] Mineral fuels, lubricants and related materials, [5] Chemicals and related products, n.e.s., and [6] Manufactured goods; IIT with Russia is at high level in [4] Animal and vegetable oils, fats and waxes, [5] Chemicals and related products, n.e.s., [7] Machinery and transport equipment, and [8] Miscellaneous manufactured articles, and at the lowest level in [0] Food and live animals, and [2] Crude materials, inedible, except fuels, over the years and IIT with South Africa is high in [6] Manufactured goods, and at lowest level in [0] Food and live animals, [1] Beverages and tobacco, [3] Mineral fuels, lubricants and related materials, and [5] Chemicals and related products, n.e.s.. Overall, India doses IIT with BRICS countries mostly in [6] manufacture goods and [5] Chemicals and related products, n.e.s., [7] Machinery and transport equipment and [3] Mineral fuels, lubricants and related materials (Table 3).

**Table 4.** Russia's IIT with BRICS Countries at SITC-One Digit Data Level

RUSSIA PRODUCT	BRAZIL			CHINA			INDIA			SOUTH AFRICA		
	2001	2010	2018	2001	2010	2018	2001	2010	2018	2001	2010	2018
ALL	0.29	0.58	0.88	0.62	0.74	0.96	0.83	0.48	0.52	0.24	0.23	0.67
0	NA	0.00	0.02	0.69	0.80	0.93	0.01	0.03	0.16	0.00	NA	0.79
1	0.00	0.01	0.01	0.01	0.10	0.95	0.00	0.00	0.01	NA	NA	0.00
2	0.63	0.27	0.35	0.10	0.07	0.08	0.94	0.41	0.57	0.56	0.11	0.21

RUSSIA PRODUCT	BRAZIL			CHINA			INDIA			SOUTH AFRICA		
	2001	2010	2018	2001	2010	2018	2001	2010	2018	2001	2010	2018
3	0.00	0.00	0.00	0.22	0.04	0.01	0.02	0.02	0.01	NA	0.25	0.04
4	NA	NA	NA	0.28	0.01	0.03	0.00	0.47	0.78	NA	0.01	NA
5	0.10	0.04	0.04	0.22	0.90	0.52	0.88	0.58	0.94	0.88	0.94	0.67
6	0.40	0.26	0.72	0.51	0.24	0.36	0.50	0.29	0.32	0.65	0.37	0.93
7	0.97	0.89	0.15	0.69	0.14	0.14	0.17	0.67	0.61	0.39	0.15	0.46
8	0.10	0.52	0.27	0.23	0.02	0.03	0.64	0.30	0.78	0.24	0.21	0.84
9	NA	0.63	0.60	0.00	0.16	0.00	0.03	0.07	0.00	0.95	0.00	0.00

**Source:** Author own calculation based on UNCTAD database accessed on 02/02/2020.

Russia's IIT with BRICS countries are in followings sectors: IIT with Brazil is high only in [6] manufacture goods and the lowest in [2] Crude materials, inedible, except fuels, and [8] Miscellaneous manufactured articles over the period; IIT with China is at high level in [0] Food and live animals, and [1] Beverages and tobacco and low level in [5] Chemicals and related products, n.e.s., and [6] Manufactured goods; IIT with India is high level in [4] Animal and vegetable oils, fats and waxes, [5] Chemicals and related products, n.e.s., and [8] Miscellaneous manufactured articles, and the low level in [7]. Machinery and transport equipment, [2] Crude materials, inedible, except fuels, and [6] Manufactured goods, over the years and IIT with South Africa is very high in [0] Food and live animals, [6] Manufactured goods, and [8] Miscellaneous manufactured articles and the low level in [5] Chemicals and related products, n.e.s. and [7] Machinery and transport equipment. Overall, Russia does IIT with BRICS countries mostly in [6] manufacture goods and [5] Chemicals and related products, n.e.s. [8], Miscellaneous manufactured articles (Table 4).

**Table 5.** South Africa's IIT with BRICS Countries at SITC-One Digit Data Level

SOUTH AFRICA PRODUCT	BRAZIL			CHINA			INDIA			RUSSIA		
	2001	2010	2018	2001	2010	2018	2001	2010	2018	2001	2010	2018
ALL	0.56	0.68	0.48	0.60	0.83	0.67	0.80	0.97	0.93	0.85	0.55	0.88
0	0.05	0.03	0.02	0.48	0.50	0.74	0.36	0.16	0.36	0.12	0.00	0.98
1	0.49	0.30	0.39	0.14	0.91	0.09	0.23	0.05	0.75	0.05	0.01	0.01
2	0.91	0.62	0.68	0.17	0.04	0.04	0.25	0.10	0.06	0.74	0.16	0.31
3	0.01	0.20	0.81	0.27	0.37	0.15	0.22	0.63	0.30	0.13	0.22	0.01
4	NA	NA	0.02	0.00	0.35	0.23	0.03	0.00	0.02	NA	0.01	NA
5	0.79	0.71	0.84	0.54	0.51	0.17	0.49	0.81	0.36	0.04	0.14	0.16
6	0.90	0.79	0.79	0.88	0.86	0.63	0.98	0.78	0.77	0.42	0.72	0.38
7	0.30	0.54	0.17	0.31	0.04	0.01	0.89	0.21	0.24	0.47	0.47	0.99
8	0.48	0.43	0.32	0.01	0.01	0.07	0.13	0.11	0.12	0.36	0.97	0.92
9	0.00	0.00	0.00	0.04	0.00	0.00	0.57	0.01	0.00	0.88	NA	0.02

**Source:** Author own calculation based on UNCTAD database accessed on 02/02/2020.

South Africa does IIT with BRICS countries in the sectors like: IIT with Brazil is high in [3] Mineral fuels, lubricants and related materials, [5] Chemicals and related products, n.e.s., and [6] Manufactured goods, and the lowest in [1] Beverages and tobacco, [2] Crude materials, inedible, except fuels, and [8] Miscellaneous manufactured articles over the period; IIT with China is high in [0] Food and live animals, and [6] Manufactured goods; IIT with India is high level in [6] Manufactured goods, and [1] Beverages and tobacco and the low level in [0] Food and live animals, [3] Mineral fuels, lubricants and related materials, and [5] Chemicals and related products, n.e.s., over the years and IIT with Russia is very high in [0] Food and live animals, [7] Machinery and transport equipment, and [8] Miscellaneous manufactured articles and the low level in [6] Manufactured goods

and [2] Crude materials, inedible, except fuels,. Overall, South Africa's IIT does with BRICS countries largely in [0] Food and live animals, [6] manufacture goods and [5] Chemicals and related products, n.e.s., [2] Crude materials, inedible, except fuels, [3] Mineral fuels, lubricants and related materials, [8] Miscellaneous manufactured articles (Table 5).

**Table 6.** Overall BRICS Countries' IIT with BRICS Countries at SITC-One Digit Data Level

BRICS	BRAZIL			CHINA			INDIA			RUSSIA			SOUTH AFRICA		
PRODUCT	2001	2010	2018	2001	2010	2018	2001	2010	2018	2001	2010	2018	2001	2010	2018
ALL	0.84	0.91	0.82	0.48	0.68	0.94	0.67	0.63	0.43	0.79	0.80	0.92	0.71	0.86	0.75
0	0.06	0.14	0.17	0.53	0.84	0.69	0.24	0.82	0.82	0.13	0.29	0.76	0.57	0.57	0.76
1	0.05	0.17	0.10	0.38	0.18	0.19	0.04	0.13	0.29	0.00	0.02	0.33	0.96	0.45	0.63
2	0.04	0.03	0.03	0.15	0.03	0.03	0.84	0.31	0.97	0.16	0.20	0.31	0.24	0.08	0.08
3	0.29	0.64	0.13	0.73	0.11	0.07	0.02	0.90	0.68	0.22	0.04	0.01	0.57	0.57	0.47
4	0.00	0.03	0.07	0.20	0.01	0.03	0.21	0.57	0.87	0.00	0.47	0.10	0.00	0.22	0.05
5	0.21	0.25	0.20	0.60	0.77	0.42	0.78	0.46	0.62	0.38	0.70	0.94	0.94	0.71	0.31
6	0.73	0.43	0.45	0.33	0.93	0.91	0.68	0.79	0.49	0.51	0.52	0.60	0.96	0.86	0.65
7	0.91	0.18	0.11	0.31	0.71	0.11	0.28	0.25	0.18	0.54	0.26	0.24	0.35	0.10	0.05
8	0.18	0.06	0.05	0.47	0.80	0.06	0.67	0.29	0.31	0.31	0.12	0.09	0.04	0.02	0.08
9	NA	0.02	0.00	0.01	0.03	0.00	0.05	0.03	0.00	0.01	0.12	0.00	0.09	0.00	0.00

**Source:** Author own calculation based on UNCTAD database accessed on 02/02/2020.

BRICS Countries' IIT with BRICS countries are in followings sectors: IIT with Brazil is low in [6] Manufactured goods, over the period; IIT with China is high in [6] Manufactured goods and the low level in [0] Food and live animals, and [5] Chemicals and related products, n.e.s.; IIT with India is high level in [0] Food and live animals, [2] Crude materials, inedible, except fuels and [4] Animal and vegetable oils, fats and waxes, and the low level in [5] Chemicals and related products, n.e.s., [6] Manufactured goods, and [3] Mineral fuels, lubricants and related materials, In addition, the lowest level IIT is in [1] Beverages and tobacco and [8] Miscellaneous manufactured articles, over the years; IIT with Russia is high in [0] Food and live animals, and [5] Chemicals and related products, n.e.s., the low level IIT is in [6] Manufactured goods and the lowest level of IIT is in [1] Beverages and tobacco and [2] Crude materials, inedible, except fuels; and IIT with South Africa is very high in [0] Food and live animals, the low level IIT is in [1] Beverages and tobacco, [6] manufacture goods and the lowest level of IIT is in [5] Chemicals and related products, n.e.s., and [3] Mineral fuels, lubricants and related materials. Overall, BRICS IIT with BRICS countries take place mostly in [0] Food and live animals, [6] manufacture goods and [5] Chemicals and related products, n.e.s., [2] Crude materials, inedible, except fuels, [3] Mineral fuels, lubricants and related materials (Table 6).

**Table 7.** Overall BRICS Countries' IIT with BRICS Countries at SITC-Two Digit Data Level in 2001

Country Name	Partner Country Name	0-0.25	0.25-0.5	0.5-0.75	0.75-1	Total No. of Industry
Brazil	China	28	13	5	3	49
	India	13	6	6	9	34
	Russian Federation	8	3	2		13
	South Africa	14	9	7	6	36
China	Brazil	28	10	6	3	47
	India	21	8	15	5	49
	Russian Federation	22	9	3	7	41
	South Africa	28	5	5	7	45
India	Brazil	11	13	4	6	34
	China	26	7	7	11	51
	Russian Federation	11	7	4	7	29
	South Africa	21	10	4	5	40

Country Name	Partner Country Name	0-0.25	0.25-0.5	0.5-0.75	0.75-1	Total No. of Industry
Russian Federation	Brazil	9	2	3	2	16
	China	24	11	5	10	50
	India	16	9	4	1	30
	South Africa	6	4	2	1	13
South Africa	Brazil	15	10	6	8	39
	China	33	2	5	8	48
	India	23	10	7	7	47
	Russian Federation	10	5	3	2	20

**Source:** Author own calculation based on UNCOMTRADE database using WITS accessed on 02/04/2020.

The results on two digit-SITC data have been reported in Tables 7-9. It shows distribution of indices' value of IIT of BRICS countries for the years such as 2001, 2010 and 2018. Further, the three years represents pre-BRICS 2001, at the BRICS formation-2010 and post-BRICS formation-2018. Furthermore, the analysis revealed that IIT at two industry level expanded over the period. This is clearly shown by three different year analysis (see Tables 7-9). However, the high level of IIT performance has observed in the nearly in single digit over the years of the analysis. Further, the results and break down high IIT indices have been reported and discussed in next paragraph. For instance, in 2001, Brazil's IIT with BRICS countries at two-digit SITC chapters are high in followings industries: IIT with China in [9] Misc food products (0.81), [66] Non-metal mineral manuf. (0.95), and [72] Industry special machine (0.86); IIT with India in [59] Chem material/prods n.e.s. (0.95), [66] Non-metal mineral manuf. (0.85), [67] Iron and steel (0.93), [72] Industry special machine (1.00), [73] Metalworking machinery (0.75), [74] Industrial equipment n.e.s. (0.90), [81] Building fixtures etc. (0.80), [82] Furniture/furnishings (0.98), and [89] Misc manufactures n.e.s. (0.85); and IIT with South Africa in [29] Crude anim/veg mater n.e.s. (0.97), [54] Pharmaceutical products (0.77), [64] Paper/paperboard/article (0.95), [69] Metal manufactures n.e.s. (0.79), [73] Metalworking machinery (0.90), and [76] Telecomms etc. equipment (0.85).

**Table 8.** Overall BRICS Countries' IIT with BRICS Countries at SITC- Two Digit Data Level in 2010

Country Name	Partner Country Name	0-0.25	0.25-0.5	0.5-0.75	0.75-1	Total No. of Industry
Brazil	China	38	7	5	3	53
	India	35	4	1	4	44
	Russian Federation	17	1	5	2	25
	South Africa	18	8	10	3	39
China	Brazil	35	8	5	3	51
	India	34	6	7	7	54
	Russian Federation	42	2	7	2	53
	South Africa	38	5	4	5	52
India	Brazil	24	7	6	5	42
	China	37	12	2	8	59
	Russian Federation	22	11	6	5	44
	South Africa	25	12	6	6	49
Russian Federation	Brazil	10	3	7	6	26
	China	39	4	5	4	52
	India	22	8	5	4	39
	South Africa	11	4	2	5	22
South Africa	Brazil	27	7	6	3	43
	China	40	6	5	9	60
	India	31	7	9	4	51
	Russian Federation	13	5	5	3	26

**Source:** Author own calculation based on UNCOMTRADE database using WITS accessed on 02/04/2020.

In addition, in 2001, China's IIT with BRICS countries at two-digit SITC chapters are high in followings industries: IIT with Brazil in [5] Vegetables and fruit (0.99), [26] Textile fibres (0.92), and [68] Non-ferrous metals (0.88); IIT with India in [9] Misc food products (0.76), [27] Crude fertilizer/mineral (0.85), [29] Crude anim/veg mater n.e.s. (0.94), [33] Petroleum and products (0.90), and [65] Textile yarn/fabric/art. (0.88); IIT with Russian Federation in [26] Textile fibres (0.83), [52] Inorganic chemicals (0.83), [61] Leather manufactures (0.77), [63] Cork/wood manufactures (0.82), [77] Electrical equipment (0.87), [78] Road vehicles (0.89), and [89] Misc manufactures n.e.s. (0.99); and IIT with South Africa in [3] Fish/shellfish/etc. (0.85), [11] Beverages (0.91), [33] Petroleum and products (0.96), [53] Dyeing/tanning/color mat (0.95), [63] Cork/wood manufactures (0.79), [71] Power generating equipment (0.98), and [74] Industrial equipment n.e.s. (0.90).

**Table 9.** Overall BRICS Countries' IIT with BRICS Countries at SITC- Two Digit Data Level in 2018

Country Name	Partner Country Name	0-0.25	0.25-0.5	0.5-0.75	0.75-1	Total No. of Industry
Brazil	China	37	9	3	7	56
	India	21	11	13	6	51
	Russian Federation	23	7	6	3	39
	South Africa	20	12	9	6	47
China	Brazil	38	11	3	5	57
	India	32	13	6	7	58
	Russian Federation	42	9	5	5	61
	South Africa	42	10	2	3	57
India	Brazil	19	12	13	7	51
	China	32	10	10	5	57
	Russian Federation	27	10	8	6	51
	South Africa	33	12	7	3	55
Russian Federation	Brazil	18	9	4	5	36
	China	40	13	3	5	61
	India	31	6	10	4	51
	South Africa	22	8	2	4	36
South Africa	Brazil	24	12	7	8	51
	China	41	7	6	5	59
	India	30	9	11	5	55
	Russian Federation	25	8	8	5	46

**Source:** Author own calculation based on UNCOMTRADE database using WITS accessed on 02/04/2020.

Further, in 2001, India's IIT with BRICS countries at two-digit SITC chapters are high in industries like: IIT with Brazil in [5] Vegetables and fruit (0.92), [67] Iron and steel (0.76), [74] Industrial equipment n.e.s. (0.81), [75] Office/dat proc machines (0.82), [82] Furniture/furnishings (0.81), and [85] Footwear (0.94); IIT with China in [4] Cereals/cereal preparatn (0.77), [8] Animal feed ex unmlcer. (0.99), [9] Misc food products (0.78), [27] Crude fertilizer/mineral (0.82), [29] Crude anim/veg mater n.e.s. (0.79), [55] Perfume/cosmetic/cleansr (0.96), [59] Chem material/prods n.e.s. (0.98), [62] Rubber manufactures n.e.s. (0.80), [65] Textile yarn/fabric/art. (0.95), [67] Iron and steel (0.77), and [93] UN Special Code (0.85); IIT with Russian Federation is in [51] Organic chemicals (0.98), [59] Chem material/prods n.e.s. (0.86), [66] Non-metal mineral manuf. (0.80), [76] Telecommsetc equipment (0.84), [87] Scientific/etc instrument (0.92), [89] Misc manufactures n.e.s. (0.81), and [93] UN Special Code (0.76); and IIT with South Africa is in [57] Plastics in primary form (0.89), [63] Cork/wood manufactures (0.87), [67] Iron and steel (0.99), [71] Power generating equipment (0.98), and [74] Industrial

equipment n.e.s. (0.92). Furthermore, in 2001, Russia Federation's IIT with BRICS countries at two-digit SITC chapters are high in followings industries: IIT with Brazil in [64] Paper/paperboard/article (0.76), and [65] Textile yarn/fabric/art. (0.77); with China in [0] Live animals except fish (0.88), [26] Textile fibres (0.86), [27] Crude fertilizer/mineral (0.84), [52] Inorganic chemicals (0.95), [59] Chem material/prods n.e.s. (0.96), [64] Paper/paperboard/article (0.87), [69] Metal manufactures n.e.s. (0.90), [72] Industry special machine (0.94), [76] Telecomms etc. equipment (0.77), and [77] Electrical equipment (0.80); IIT with India only in [62] Rubber manufactures n.e.s. (0.80); and with South Africa only in [51] Organic chemicals (0.87). Lastly, in 2001, South Africa's IIT with BRICS countries at two-digit SITC chapters are high such as IIT with Brazil in [27] Crude fertilizer/mineral (0.88), [51] Organic chemicals (0.87), [67] Iron and steel (0.98), [69] Metal manufactures n.e.s. (0.83), [73] Metalworking machinery (0.88), [84] Apparel/clothing/access (0.86), [87] Scientific/etc. instrument (0.90), and [88] Photographic equ/clocks (0.85); with China in [11] Beverages (0.93), [27] Crude fertilizer/mineral (0.86), [51] Organic chemicals (0.91), [53] Dyeing/tanning/color mat (0.91), [64] Paper/paperboard/article (0.75), [71] Power generating equipment (0.99), [73] Metalworking machinery (0.99), and [74] Industrial equipment n.e.s. (0.97); IIT with India in [33] Petroleum and products (0.76), [51] Organic chemicals (0.91), [59] Chem material/prods n.e.s. (0.94), [71] Power generating equipment (0.77), [74] Industrial equipment n.e.s. (0.88), [76] Telecomms etc equipment (0.85), and [77] Electrical equipment (0.90); and IIT with Russian Federation is in [75] Office/dat proc machines (0.83), and [77] Electrical equipment (0.77).

Further, in 2010, Brazil's IIT with BRICS countries at two-digit SITC chapters are high in followings industries: IIT with China is in [6] Sugar/sugar prep/honey (0.81), [7] Coffee/tea/cocoa/spices(0.78), and [66] Non-metal mineral manif.(0.87); IIT with India in [23] Crude/synthet/rec rubber (0.98), [68] Non-ferrous metals (0.99), [71] Power generating equipment (0.90), [88] Photographic equ/clocks (0.90), and [89] Misc manufactures n.e.s. (0.96); IIT with Russian Federation is in [25] Pulp and waste paper (0.97), [68] Non-ferrous metals (0.75), [74] Industrial equipment n.e.s. (0.79), [75] Office/dat proc machines (0.79), [78] Road vehicles (0.80), and [89] Misc manufactures n.e.s. (0.94); and IIT with South Africa is in [53] Dyeing/tanning/color mat (0.88), [59] Chem material/prods n.e.s. (0.94), and [62] Rubber manufactures n.e.s. (0.94). In addition, in 2010, China's IIT with BRICS countries at two-digit SITC chapters are high in industry like: IIT with Brazil is in [54] Pharmaceutical products (0.85), [57] Plastics in primary form (0.98) and [61] Leather manufactures (0.99); IIT with India is in [7] Coffee/tea/cocoa/spices (0.95), [22] Oil seeds/oil fruits (0.92), [23] Crude/synthet/rec rubber (0.91), [41] Animal oil/fat (0.82), [51] Organic chemicals (0.81), [54] Pharmaceutical products (0.96), [57] Plastics in primary form (0.80), and [67] Iron and steel (0.94); IIT with Russian Federation is in [8] Animal feed ex unmlcer. (0.78), [57] Plastics in primary form (0.88), [67] Iron and steel (0.98), and [72] Industry special machine (1.00); and IIT with South Africa is in [3] Fish/shellfish/etc. (0.91), [11] Beverages (0.92), [27] Crude fertilizer/mineral (0.92), [51] Organic chemicals (0.96), [52] Inorganic chemicals (0.99), [57] Plastics in primary form (0.89), [68] Non-ferrous metals (0.98), [78] Road vehicles (0.94), and [93] UN Special Cod (1.00). Further, in 2010, India's IIT with BRICS countries at two-digit SITC chapters are high in industries

like: IIT with Brazil in [7] Coffee/tea/cocoa/spices (0.89), [57] Plastics in primary form (0.82), [61] Leather manufactures (0.76), and [71] Power generating equipment (0.85); IIT with China in [3] Fish/shellfish/etc. (0.84), [6] Sugar/sugar prep/honey (0.96), [28] Metal ores/metal scrap (0.81), [32] Coal/coke/briquettes (0.78), [59] Chem. material/prods n.e.s. (0.76), [61] Leather manufactures (0.84), and [88] Photographic equ/clocks (0.82); IIT with Russian Federation is in [26] Textile fibres (0.97), [28] Metal ores/metal scrap (0.80), [57] Plastics in primary form (0.99), and [77] Electrical equipment (0.79) and IIT with South Africa is in [29] Crude anim/veg mater n.e.s. (0.96), [66] Non-metal mineral manuf. (0.88), [68] Non-ferrous metals (0.90), and [87] Scientific/etc instrument (0.97). Furthermore, in 2010, Russia's IIT with BRICS countries at two-digit SITC chapters are high in followings industries: IIT with Brazil in [58] Plastics non-primry form (0.98), and [65] Textile yarn/fabric/art. (0.91); IIT with China in [33] Petroleum and products (0.94), and [51] Organic chemicals (0.79); IIT with India in [9] Misc food products (0.95), [23] Crude/synthet/rec rubber (0.97), [64] Paper/paperboard/article (0.76), [71] Power generating equipment (0.92), and [75] Office/dat proc machines (0.90); and IIT with South Africa is in [76] Telecomms etc equipment (0.90), [78] Road vehicles (0.98), and [87] Scientific/etc instrument (0.95). Finally, in 2010, South Africa's IIT with BRICS countries at two-digit SITC chapters are high industries such as: IIT with Brazil in [51] Organic chemicals (0.95), [52] Inorganic chemicals (0.98), and [65] Textile yarn/fabric/art. (0.85); IIT with China in [9] Misc food products (0.91), [42] Fixed veg oils/fats (0.81), [65] Textile yarn/fabric/art. (0.99), [73] Metalworking machinery (0.84), and [88] Photographic equ/clocks (0.85); IIT with India in [9] Misc food products (0.89), [26] Textile fibres (0.95), [52] Inorganic chemicals (0.86), [55] Perfume/cosmetic/cleansr (0.95), [71] Power generating equipment (0.86), and [75] Office/dat proc machines (0.93); IIT with Russian Federation in [52] Inorganic chemicals (0.89), [64] Paper/paperboard/article (0.94), [65] Textile yarn/fabric/art. (0.94), [78] Road vehicles (0.84), and [89] Misc manufactures n.e.s. (0.87).

Furthermore, in 2018, Brazil's IIT with BRICS countries at two-digit SITC chapters are high in followings industries: IIT with China in [8] Animal feed ex unmlcer. (0.89), [23] Crude/synthet/rec rubber (0.81), [55] Perfume/cosmetic/cleansr (0.99), [57] Plastics in primary form (0.91), [63] Cork/wood manufactures (0.86), [67] Iron and steel (0.87), and [68] Non-ferrous metals (0.77); IIT with India is in [26] Textile fibres (0.83), [55] Perfume/cosmetic/cleansr (0.97), [67] Iron and steel (0.98), [72] Industry special machine (0.97), [73] Metalworking machinery (0.75), and [76] Telecomms etc equipment (0.82); IIT with Russian Federation is in [4] Cereals/cereal preparatn (0.81), [51] Organic chemicals (0.96), and [75] Office/dat proc machines (0.80); and IIT with South Africa is in [26] Textile fibres (0.78), [28] Metal ores/metal scrap (0.78), [53] Dyeing/tanning/color mat (0.91), [65] Textile yarn/fabric/art. (0.92), [67] Iron and steel (0.96), and [84] Apparel/clothing/access (0.86). In addition, in 2018, China's IIT with BRICS countries at two-digit SITC chapters are high in industries like: IIT with Brazil in [5] Vegetables and fruit (0.93), [26] Textile fibres (0.79), [57] Plastics in primary form (0.79), [67] Iron and steel (0.85), and [68] Non-ferrous metals (0.93); IIT with India is in [5] Vegetables and fruit (0.79), [8] Animal feed ex unmlcer. (0.78), [23] Crude/synthet/rec rubber (0.87), [29] Crude anim/veg mater n.e.s. (0.97), [33] Petroleum and products (0.95), [41] Animal oil/fa (0.87), and [66] Non-metal mineral manuf. (0.79); IIT

with Russian Federation takes place in [11] Beverages (0.78), [12] Tobacco/manufactures (0.79), [52] Inorganic chemicals (0.79), [61] Leather manufactures (0.80), [63] Cork/wood manufactures (0.84); and IIT with South Africa is in [6] Sugar/sugar prep/honey (0.96), [27] Crude fertilizer/mineral (0.88), and [54] Pharmaceutical products (0.88). On the other hand, in 2018, India's IIT with BRICS countries at two-digit SITC chapters are high in followings: IIT with Brazil is in [12] Tobacco/manufactures (0.96), [26] Textile fibres (0.87), [52] Inorganic chemicals (0.80), [66] Non-metal mineral manuf. (0.80), [67] Iron and steel (0.78), [73] Metalworking machinery (0.87), and [85] Footwear (0.98); IIT with China takes place in [6] Sugar/sugar prep/honey (0.88), [12] Tobacco/manufactures (0.96), [22] Oil seeds/oil fruits (0.85), [29] Crude anim/veg mater n.e.s. (0.79), and [57] Plastics in primary form (0.97); IIT with Russian Federation largely happens in [51] Organic chemicals (0.86), [61] Leather manufactures (0.91), [72] Industry special machine (0.77), [75] Office/dat proc machines (0.86), [79] Railway/tramway equipment (0.86), and [87] Scientific/etc instrument (0.89); and IIT with South Africa is in [11] Beverages (0.84), [23] Crude/synthet/rec rubber (0.84), and [57] Plastics in primary form (0.79). Additionally, in 2018, Russian Federation's IIT with BRICS countries at two-digit SITC chapters are high in industries such as: IIT with Brazil is in [25] Pulp and waste paper (0.75), [57] Plastics in primary form (0.77), [62] Rubber manufactures n.e.s. (0.87), [63] Cork/wood manufactures (0.77), and [82] Furniture/furnishings (0.98); IIT with China in [7] Coffee/tea/cocoa/spices (0.97), [8] Animal feed ex unmlcer. (0.98), [64] Paper/paperboard/article (0.86), [71] Power generating equipment (0.86), and [79] Railway/tramway equipment (0.96); IIT with India in [61] Leather manufactures (0.82), [69] Metal manufactures n.e.s. (0.90), [72] Industry special machine (0.87), and [77] Electrical equipment (0.83); and IIT with South Africa takes place in [59] Chem material/prods n.e.s. (0.99), [84] Apparel/clothing/access (0.92), [88] Photographic equ/clocks (0.99), and [89] Misc manufactures n.e.s. (0.82). Lastly, in 2018, South Africa's IIT with BRICS countries at two-digit SITC chapters are high in followings industries: IIT with Brazil is in [3] Fish/shellfish/etc. (0.78), [5] Vegetables and fruit (0.91), [27] Crude fertilizer/mineral (0.91), [28] Metal ores/metal scrap (0.75), [51] Organic chemicals (0.99), [68] Non-ferrous metals (1.00), [69] Metal manufactures n.e.s. (0.81), and [89] Misc manufactures n.e.s. (0.86); IIT with China takes place in [6] Sugar/sugar prep/honey (0.82), [8] Animal feed ex unmlcer. (0.75), [12] Tobacco/manufactures (0.90), [27] Crude fertilizer/mineral (0.82), and [42] Fixed veg oils/fats (0.79); with India in [5] Vegetables and fruit (0.77), [26] Textile fibres (0.90), [66] Non-metal mineral manuf. (0.88), [75] Office/dat proc machines (0.97), and [79] Railway/tramway equipment (0.96); and IIT with Russian Federation is in [0] Live animals except fish (0.90), [55] Perfume/cosmetic/cleansr (0.87), [59] Chem material/prods n.e.s. (0.95), [71] Power generating equipment (0.81), and [79] Railway/tramway equipment (0.96).

### Dynamic IIT analysis

The analysis has been carried out at four digit-SITC data for the three sub period such as 2000-2005, 2009-2014 and 2015-2018. The followings process has been adopted to carry out analysis of MIIT: Firstly, data of four digits SITC has been deflated to get the real change during the selected period by consumer price index of United States of America

collected from World Development Indicator, World Bank database and its base year is 2010. This method used because of non-availability of export/import unit price index for all BRICS countries. Secondly, regular trade flow of selected sub-period has been considered in the analysis, e.g. Ferto (2008). Thirdly, sub-sectors are defined in this analysis at four digits and aggregated to calculate industry at two-digit SITC level. Fourthly, both indices have been added over all sectors by trade weight. Finally, the results have been reported in Tables 10-12.

The analysis sample size has been selected as per above said criteria such as in 2000-2005, 554 sub-industries and 55 industries were selected, 707 sub-industries and 60 industries were chosen during 2009-2014 and in 2015-2018, 760 sub-industries and 60 industries were selected for the analysis of MIIT of BRICS countries. Further, in 2000-2005, Brazil trade with BRICS countries is more or less IT except with India; it was VIIT nearly 50%. China trade with BRICS countries is almost IT. India trade with BRICS countries is dominated by IT except with Russia, it was HIIT. Russia trade with BRICS countries is approximately IT. South Africa trade with BRICS countries is largely IT. In addition, South Africa trade with Brazil show 30% VIIT. Nonetheless, South Africa has not been observed an active trade partner with the BRICS countries during 2000-2005 (see Table 10).

**Table 10.** *Decomposition Trade Flow of BRICS Countries during 2000-2005*

Country Name	Partner Country Name	AJ IIT	AW HIIT	AJ-AW VIIT	1-AJ IT
Brazil	China	0.22	0.13	0.09	0.78
	India	0.67	0.17	0.50	0.33
	Russian Federation	0.14	0.14	0.00	0.86
China	Brazil	0.30	0.17	0.13	0.70
	India	0.32	0.18	0.13	0.68
	Russian Federation	0.17	0.09	0.08	0.83
India	Brazil	0.28	0.10	0.18	0.72
	China	0.25	0.14	0.11	0.75
	Russian Federation	0.60	0.60	0.00	0.40
Russian Federation	Brazil	0.00	0.00	0.00	1.00
	China	0.25	0.12	0.13	0.75
	India	0.31	0.09	0.22	0.69
South Africa	Brazil	0.46	0.16	0.30	0.54
	China	0.10	0.09	0.02	0.90
	India	0.29	0.15	0.14	0.71

**Source:** Author own calculation based on UNCOMTRADE database using WITS accessed on 02/04/2020.

Additionally, in 2009-2014, Brazil trade with BRICS countries is more or less IT except with India; it was both HIIT and VIIT nearly 16% and 15% respectively. China trade with BRICS countries almost concentrated to Brazil and India, where, trade with Brazil is almost IT. On the other hand, trade with India is vertically integrated within the same Industry. Further, India trade with BRICS countries is dominated by IT except with Brazil and China, where, it was both HIIT (nearly 26% and 17%) and VIIT (around 21% and 22%), respectively. Russia trade with BRICS countries is approximately IT. Nonetheless, Russia trade with Brazil is HIIT nearly 20% and trade with India is close to 38% vertically integrated in the same industry. And South Africa trade with BRICS countries is largely IT. In addition, South Africa trade with Brazil reveals both nearly 22% HIIT

and 21% VIIT has been observed. Nonetheless, South Africa trade with India and China accounts for 18% and 15% of VIIT respectively, during 2009-2014 (see Table 11).

**Table 11.** *Decomposition Trade Flow of BRICS Countries during 2009-2014*

Country Name	Partner Country Name	AJ IIT	AW HIIT	AJ-AW VIIT	1-AJ IT
Brazil	China	0.11	0.04	0.07	0.89
	India	0.31	0.16	0.15	0.69
	Russian Federation	0.10	0.10	0.00	0.90
	South Africa	0.06	0.06	0.00	0.94
China	Brazil	0.15	0.05	0.10	0.85
	India	0.39	0.09	0.29	0.61
India	Brazil	0.35	0.13	0.22	0.65
	China	0.37	0.12	0.25	0.63
	Russian Federation	0.01	0.01	0.00	0.99
	South Africa	0.00	0.00	0.00	1.00
Russian Federation	Brazil	0.29	0.20	0.09	0.71
	China	0.09	0.03	0.06	0.91
	India	0.47	0.09	0.38	0.53
	South Africa	0.09	0.09	0.00	0.91
South Africa	Brazil	0.43	0.22	0.21	0.57
	China	0.18	0.04	0.15	0.82
	India	0.26	0.08	0.18	0.74

**Source:** Author own calculation based on UNCOMTRADE database using WITS accessed on 02/04/2020.

Additionally, in 2015-2018, Brazil trade with BRICS countries is more or less IT except with India and China; where trade with India is HIIT (13%) as well as VIIT (33%) and trade with China is VIIT nearly 46%. Further, China trade with BRICS countries takes place mostly with Brazil and India, such as trade with Brazil is VIIT nearly 50% and trade with India is HIIT (14%) and VIIT (31%) as well. India trade with BRICS countries is dominated by IT. Nevertheless, IIT trade also observed between India and BRICS countries, where HIIT accounts the highest such as Brazil (26%), China (17%), Russia (2%) and South Africa (16%). In addition, VIIT also observed Brazil and China 21% and 22%, respectively.

On the other side, Russia trade with BRICS countries is approximately IT except India, where its percentage share in trade flow is 51%. Nevertheless, Russia's trade with BRICS countries also observed VIIT such as trade with Brazil, China and India accounts for 15%, 27%, 41% respectively. And South Africa trade with BRICS countries is mostly IT. However, South Africa's trade with BRICS countries also reveals IIT, where, South Africa's VIIT with Brazil, China and India accounts for 24%, 27% and 11% respectively. In addition, HIIT only takes place between South Africa and Brazil stands for 10% only, during 2015-18 (see Table 12).

**Table 12.** *Decomposition Trade Flow of BRICS Countries during 2015-2018*

Country Name	Partner Country Name	AJ IIT	AW HIIT	AJ-AW VIIT	1-AJ IT
Brazil	China	0.52	0.05	0.46	0.48
	India	0.46	0.13	0.33	0.54
	Russian Federation	0.00	0.00	0.00	1.00
	South Africa	0.00	0.00	0.00	1.00
China	Brazil	0.54	0.04	0.50	0.46
	India	0.46	0.14	0.31	0.54

Country Name	Partner Country Name	AJ IIT	AW HIIT	AJ-AW VIIT	1-AJ IT
India	Brazil	0.46	0.26	0.21	0.54
	China	0.39	0.17	0.22	0.61
	Russian Federation	0.02	0.02	0.00	0.98
	South Africa	0.16	0.16	0.00	0.84
Russian Federation	Brazil	0.17	0.03	0.15	0.83
	China	0.33	0.05	0.27	0.67
	India	0.49	0.08	0.41	0.51
	South Africa	0.00	0.00	0.00	1.00
South Africa	Brazil	0.34	0.10	0.24	0.66
	China	0.29	0.02	0.27	0.71
	India	0.14	0.03	0.11	0.86
	Russian Federation	0.00	0.00	0.00	1.00

**Source:** Author own calculation based on UNCOMTRADE database using WITS accessed on 02/04/2020.

## Discussion

The GLI indices values is in line with Grubel and Lloyd (1971), Leitão (2011). Further, the MIIT indices values are also in line with Brulhart (1994) and Thomand and McDowell (1999).

In addition, the value of both the static and dynamic indices should not be greater than one have been observed from the analysis, which is in line with literature of IIT. For example, Proença and Faustino (2015), Filipowicz (2016), Şahbudak and Şahin (2016), Maxir and Masullo (2017), Mutambara (2017), Dwesar and Kesharwani (2019) and Varshini and Manonmani (2019). Hence, the results are very robust and reliable.

## Conclusion and policy implications

In this article, we tried to investigate Intra-Industry Trade among the BRICS countries. IIT measured by using Grubel and Lloyd IIT Index for static analysis and Thom and McDowell (1999) MIIT index for dynamic analysis. In addition, the decomposition of IIT carried out to distinguish between Horizontal and Vertical IIT at Industry level (two digits- SITC level data). The unit of analysis selected at one- digit and two-digit SITC Industry level for GL IIT index. Further, to conduct MIIT analysis, industry is defined at two-digit-SITC level data by aggregating four-digit SITC sub-industry level data of IIT of BRICS countries. Further, study analysed the Pre and Post-BRICS trade pattern of IIT. Thereafter, this study emphasises that do emerging economies IIT among themselves? On the basis of estimated results of this study revealed that IIT occurs at higher level of aggregation. This signifies that developing countries are trading in the same Industry for love for variety and cost effectiveness. In addition, evidence on MIITI shows that BRICS countries' IIT increased over the period. Besides, BRICS countries get benefited from IIT over the years and since BRICS inception as well, which is validated by MIITI values. Hence, the empirical result contradicts conventional Krugman (1979, 1985) hypothesis of IIT takes place in developed nations (industrialist nations).

With respect to the policy implications, BRICS countries should focus on opportunities of trade complementary of intermediates products. This will enhance cost effectiveness of product development or production. Further, this will promote innovation in the BRICS region. To achieve this, countries need to conduct constructive trade dialog among the BRICS countries.

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## Appendix

SITC (Standard International Trade Classifications)-one digit. It includes ten sectors such as total all products, [0] Food and live animals, [1] Beverages and tobacco, [2] Crude materials, inedible, except fuels, [3] Mineral fuels, lubricants and related materials, [4] Animal and vegetable oils, fats and waxes, [5] Chemicals and related products, n.e.s., [6] Manufactured goods, [7] Machinery and transport equipment, [8] Miscellaneous manufactured articles, [9] Commodities and transactions, n.e.s.