ISSN 2454-5597

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Working Paper – 34
http://iire.in/ojs/index.php
Issue –April 2018

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PRODUCT QUALITY INDEX: A NEW WAY TO CLASSIFY INTRA-INDUSTRY TRADE *

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Abstract

The increasing intra-industry trade (IIT) gives an impetus to theoretical foundations of new trade theories. For the empirical assessment the measurement and segregation of IIT become very essential. On the basis of quality of product, IIT is segregated into two parts. First, is based on qualitative differentiation of the products, known as vertical intra-industry trade (VIIT) and the second is based on the differentiation of the products called as horizontal intra-industry trade (HIIT). The work of Greenaway, Hine and Milner (1994) (GHM), Fontagane and Freudenberg (1997) (FF) and Azhar and Elliott (2006) (AE) are some of the milestones in the methodological development of IIT. However, these methods are not free from certain shortcomings. Thus, the paper attempts to extend the measurement technique with product quality index (PQI) to overcome the existing shortcomings such as arbitrariness of dispersion limit and bias in the classification of IIT into HIIT and VIIT.

Keywords: Intra-industry trade, product differentiation, horizontal intra-industry trade, vertical intra-industry trade, low quality intra-industry trade, high quality intra-industry trade.

JEL Codes: F140

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* The authors wish to thank Professor Rajat Acharyya for useful suggestions and comments. However, the authors remain solely responsible for any remaining errors.

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1. INTRODUCTION:

Increase in trade within industry paved a way for the complementary approach for new trade theories. Prior to new trade theories, it is often argued that factor endowment difference between the countries is crucial for engaging in foreign trade. However, the growing dominance of intra-industry trade (IIT) proved that countries with similar factor endowment also gain from trade. In addition to this, reallocation of resources within the same industry is easier and cheaper as factors of production and skills of labour remain the same. On the other hand, the shifting of resources from one industry to another is costlier because factors of production, use of technical know-how, and requirement of labour skill differ from industry to industry. Thus, the trade adjustment cost is less for IIT as compared to the inter-industry trade. Therefore, the correct measurement and segregation of IIT becomes essential for the empirical verification.

The literature regarding IIT is concerned with two distinct strands. First aspect focuses on the quantitative or volume-based measurement of IIT which examines the problems arising with given measurement technique, aggregation and issues related with the changing dynamics of IIT. Second aspect is related with the qualitative or value-based measurement of IIT. In case of qualitative measurement, the focus is on the segregation of IIT. On the basis of product quality, IIT is segregated into horizontally differentiated intra-industry trade (HIIT) and vertically differentiated intra industry trade (VIIT). In case of HIIT, products are close substitutes to each other and differentiable only in their outer attributes. VIIT, on the other hand, is associated with large differences in the quality of products. Various indices are developed to segregate IIT into HIIT and VIIT. The issue pertaining to segregation of IIT is important because it is essential to segregate IIT to measure the appropriate trade adjustment cost. In addition to this, it is also important to know the quality of IIT products. This aspect is explained by the 'Quality Ladder Hypothesis'. According to the quality ladder theory, the high-income countries export high-price and high-quality products while low income countries export low-quality and low-price products. With economic development of the country, there is a shift from low-quality exports to high-quality exports. This implies the qualitative improvement in products traded in foreign trade and considered as the country is moving up on its ‘quality ladder’ (Ando, 2006). The segregation of IIT helps to test this hypothesis.

The methodological developments related to segregation of IIT have undergone through difficult task of developing the index with which products within the same industry can be differentiated. The pioneering work in this regard is made by Abd-el-Rahman (1991). Thereafter, two broadly similar methods have been developed to differentiate IIT. First method has been suggested by, Greenaway, Hine and Milner (1994) (GHM) based on work of Abd-el-Rahman (1991). Second is developed by Fontagane and Freudenberg (1997) (FF) which is also based on work of Abd-el-Rahman (1991). Furthermore, Azhar and Elliott (2006) (AE) criticised FF and GHM methods and developed new index to segregate IIT. However, the major drawback of the methods developed by GHM, FF and AE are related with the dispersion percentile (α) to segregate IIT into HIIT and VIIT. The value of (α) is considered as an arbitrary one. Thus, the segregation of IIT varies according to the choice of dispersion percentile. Although, the choice of cut-off point is crucial as it leads to change in the proportion of IIT into each category. It is also argued that cut off point may differ as per the country specific factors such as tariff rate, transportation cost, *etc*. Therefore, the choice of cut-off point creates the ambiguity in the empirical results. Furthermore, the existing GHM, FF and AE indices are based on unequal proportion of IIT into HIIT and VIIT. As a result there is upward (downward) bias in the measurement of VIIT (HIIT). The propose methodology in tries to overcome these issues.

Based on the work of Azhar and Elliott (2006), the ‘Product Quality Index’ (PQI) is developed. PQI helps to remove the randomness in the selection of dispersion limit. Thus, attempts are made to find out the solution for the measurement problem and develop a new measurement technique to overcome the existing shortcomings in dispersion percentile.

The remaining paper is organized as follows: Section *Two* reviews the theoretical and methodological development related to HIIT and VIIT. Section *Three* provides the details about the construction of PQI. The empirical assessment of PQI is presented in Section *Four*. Section *Five* concludes the paper.

2. REVIEW OF LITERATURE:

The theoretical evolution of IIT dates back to 1960s. The term IIT was introduced by Balassa (1966) in the year 1966. To measure the extent to which the export of given commodities is equivalent to the import of the same commodities, he developed an index which is known as Balassa index. It was first attempt to measure IIT. Furthermore, Grubel and Lloyd (1975) (GL) made simple modification in Balassa index and created a new milestone in the methodological development of IIT. At the next stage theoretical underpinning related with IIT to focus on the segregation of IIT. The exchange of products within same industry takes place because of differentiation in the outer attributes of the products such as colour, packing, *etc*. or the qualitative differences in the similar looking products. The consumer preferences also play a crucial role in influencing the demand for IIT products. Theories given by Dixit-Stiglitz (1977), Krugman (1979) and Lancaster (1980) considered as demand-side theories, focused on increasing income disparity that gave rise to demand for variety of products and hence IIT. In these types of theories consumer preference played a crucial role to bifurcate demand. Moreover, theories given by Shaked and Sutton (1984), Falvey (1981) focused either on product differentiation or on economies of scale arising from product specialization. Along with the theoretical development the measurement of related techniques evolved over the period of time.

The pioneering work related to segregation of IIT was done by Abd-el-Rehman (1991). He studied foreign trade of France for the year 1984, 1986 and 1987. Using harmonised nomenclature for the foreign trade statistics of the EEC countries at the 6-digit level he analysed IIT of France with Europe and the world. He found that horizontally differentiated trade accounted for almost half of French trade in manufactures, both with Europe and with the world. He classified trade as intra-industry trade when the value of the minority trade flow (import) is represented at least 10 per cent of the majority of the trade flow (export). The proposed index for the measurement is given as:

$$\text{Two-way trade index} = \frac{\text{Min}\left(X_{p,t},\ M_{p,t}\right)}{\text{Max}\ \left(X_{p,,t},\ M_{p,t}\right)} > \gamma\ \% \qquad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where,

X = Export of product

M = Import of product

p = traded product

t = time period

Thus, the proposed index used 10 per cent threshold limit (γ=10) for defining two way trade. In this case when either exports or imports are equal to zero or less than 10 per cent comparing to each other then it is considered as one-way trade or inter industry trade. Abd-el-Rehman (1991) follows different approach as compared with earlier GL index. The GL Index measures the degree of trade overlap, while the two-way trade index considers the threshold limit. GL Index did not differentiate between one-way trade and two-way trade by using any threshold limit. The simultaneous import and export of the same product is considered as two-way traded product when GL index is greater than zero. The threshold limit for GL index to classify between intra-industry trade and inter-industry trade is equal to zero (Andresen, 2003). Furthermore, using the following index the two-way trade is segregated into two parts. First part is considered as vertically differentiated trade called as intra-range trade. Second category consists of horizontally differentiated trade, which is known as two-way trade in similar products. Horizontally differentiated products are then defined as the ratio of export unit value to import unit value falling within the given range. The 15 per cent range is chosen arbitrary, assuming that 15 per cent difference between export unit value and import unit value is sufficient to display the qualitative difference between two products (Abd-el-Rehman, 1991). Following, this notion GHM used two threshold limits of 15 per cent and 25 per cent to distinguish IIT. The index is developed as,

$$1-\alpha \leq \frac{UV_i^X}{UV_i^M} \leq 1+\alpha \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where,

α = Threshold limit

UV_i^X = Export Unit Value of i[th] product

UV_i^M = Import Unit Value of i[th] product

On the basis of the ratio of export unit value to import unit value, if it lies within the range of threshold limit, IIT is segregated as HIIT. On the other hand when the ratio of export unit value to import unit value lies outside the given range, then IIT is classified as VIIT. VIIT is then segregated into low-quality VIIT (LVIIT) when the ratio is less than (1- α) and high-quality VIIT (HVIIT) when the ratio is greater than 1+ α. GHM index assumes that that the threshold limit of 15 per cent is not sufficient to distinguish IIT into HIIT and VIIT because of differences in the transport and other freight costs in export unit value and import unit value. Therefore, to test the sensitivity of the threshold limit they have used the threshold limit of 25 per cent, then products for which the export unit value of the product is greater than 1.25 of import unit value is defined as HVIIT. Similarly, when exports unit value of product is less than 0.75 of the import unit value is regarded as LVIIT.

Greenaway *et. al* (1995) studied UK trade with its trading partner countries for the year 1988. The IIT has been calculated by using unadjusted GL index at 5-digit SITC level. The threshold limits of 15 per cent as well as 25 per cent are used to check the sensitivity of the IIT. The result shows that as the threshold limit changed from 15 to 25 per cent the dominance of VIIT decreased but the overall dominance of VIIT continued to be on the higher side. Furthermore, FF (1997) criticized GHM method by arguing that there is asymmetry in classifying VIIT and HIIT. According to them, "*…..the threshold of 25 per cent means that export unit values can be 1.25 times higher than those for imports to fulfil the similarity condition. The lower limit in that case is 0.75: import unit values need to represent at least 75 per cent of export unit values. But export unit values can be 1.33 (1/0.75) times higher than import unit values, a condition which is incompatible with the condition on the right* …."(FF 1997, P.29). Thus, to maintain the symmetry, the FF (1997) made small change in the way to segregate IIT. The FF (1997) index classifying IIT in a way:

$$\frac{1}{1+\alpha} \leq \frac{UV_i^X}{UV_i^M} \leq 1+\alpha \qquad \text{………………….} (3)$$

Following the similar criteria like GHM (1994) FF methodology distinguished IIT at the threshold limit of 15 per cent. However, the technical difference between these FF (1997) and GHM (1994) method is, with similar dispersion value the condition to distinguish IIT differs. FF method used (1/1+α) instead of (1- α) to differentiate VIIT and HIIT. The lower limit for FF and GHM method is near to zero. On the other hand, there is no upper limit for FF and GHM indices. Both FF and GHM consider the ratio of unit value of exported product to unit value of the imported product to classify IIT. Furthermore, when the arbitrary dispersion limit has chosen to segregate IIT, the problem of unequal classification of IIT arises. With the arbitrary selection of dispersion limit the IIT is classified unequally into HIIT and VIIT. For example, if the dispersion limit of 15 per cent is chosen to segregate IIT, then the 30 per cent space is covered by the HIIT products and the reaming is for VIIT products. As there is more space for VIIT products there is upward bias in the measurement of VIIT index. In addition to this, based on Abd-el-Rehman (1991) foundation, two-way trade is defined with the concept of trade overlap. An arbitrary value is chosen to be 10 per cent to segregate one-way and two- way traded products. The degree of trade overlap above 10 per cent is considered as IIT and below the given cut off point reflects one-way trade. It is argued that for small values of threshold limits there is no significant difference between the GHM and FF methods.

According to Azhar and Elliott (2006) (AE) the GHM and FF methods did not consider the proportionality effect, *i.e.*, when the unit values of exports and imports are equal but with opposite sign. However, problem arises with the disproportionate scaling with the unit values of export and import of the product. To solve this problem, they proposed a complementary approach 'Product Quality Space' (PQS) to distinguish IIT. Before the measurement of PQS, PQH and PQV are estimated as:

$$PQH = 1 - \frac{UV^X - UV^M}{(UV^X + UV^M)} \qquad \text{…………….. (4)}$$

Alternatively, PQV index can be written for vertical product differentiation:

$$PQV = 1 + \frac{UV^X - UV^M}{(UV^X + UV^M)} \qquad \text{………….. (4.1)}$$

According to Azhar and Elliott (2006), a two-way trade in the products is considered as horizontally differentiated if import and export unit values of the products are at least 85 per cent of their cost. "Intuitively, as quality reflects price it is useful to consider similarity in costs as a means of choosing a cut-off point. What percentage of costs, therefore, does two-way trade need to share to be considered as horizontally differentiated? For example, if the imports and exports of a product share at least 85 per cent of their costs (reflected in the price per unit of output) then it is not unreasonable to consider this as two-way trade in a horizontally differentiated product. Likewise, if the costs of the export country exceed those of the import country by 50 per cent (so they only share 50 per cent) then it would seem reasonable to classify this IIT as VIIT" (Azhar and Elliott, 2006, P. 485). With a cut-off of 85 per cent, the PQV index distinguishes IIT. Thus, from a home country perspective, IIT is classified as HIIT, if $0.85 \leq PQV \leq 1.15$ and VIIT otherwise. VIIT is further classified into low quality vertically differentiated products if $PQV < 0.85$ and considered as high quality vertically differentiated product if $PQV > 1.15$. The lower and upper bound for AE method are zero and two respectively, the index ranges between 0 to 2. Thus, if it is considered that total space between 0 to 2 is equal to hundred per cent, then with the 15 per cent cut of point, the space for HIIT is equal to 30 per cent of the total space. The remaining 70 per cent space is allocated for VIIT products. Thus, the segregation of IIT creates an upward (downward) bias in the measurement of VIIT (HIIT).

In nutshell, the studies pertaining to classification of IIT faced two drawbacks. Firstly, the arbitrary selection of dispersion limit leads to randomness in the classification of IIT. Secondly, the unequal proportion between HIIT and VIIT leads to upward bias in the VIIT products while segregating the IIT or downward bias in HIIT. Thus, the proposed PQI index tries to overcome these shortcomings.

3. CONSTRUCTION OF PQI:

The GL index is used to estimate IIT. Similar to earlier methodologies the unit value is measured by dividing monetary value of the product by the quantity of the product. The PQXI (PQMI) is same as the PQV (PQH) index explained in Azhar and Elliott (2006). Implicitly, quality of the product is reflected by unit value (price) of the product. Therefore, PQXI and PQMI are defined on the basis of unit value of exports and imports.

$$PQXI_i = 1 + \frac{UV_i^X - UV_i^M}{UV_i^X + UV_i^M} \quad \text{………..…… (5)}$$

$$PQXI_i = \frac{UV_i^X + UV_i^M + \left(UV_i^X - UV_i^M\right)}{UV_i^X + UV_i^M} \quad \text{…..……. (5.1)}$$

$$PQXI_i = \frac{UV_i^X + UV_i^M + UV_i^X - UV_i^M}{UV_i^X + UV_i^M} \quad \text{…..……… (5.2)}$$

$$PQXI_i = \frac{UV_i^X + UV_i^X}{UV_i^X + UV_i^M} \quad \text{…..………… (5.3)}$$

$$PQXI_i = \frac{2UV_i^X}{UV_i^X + UV_i^M} \quad \text{………… (5.4)}$$

$$PQXI_i = 2\left(\frac{UV_i^X}{UV_i^X + UV_i^M}\right) \quad \text{..………… (5.5)}$$

$$PQXI_i = \frac{2}{1} * \left(\frac{UV_i^X}{UV_i^X + UV_i^M}\right) \quad \text{………… (5.6)}$$

$$PQXI_i = \frac{\left(\frac{UV_i^X}{UV_i^X + UV_i^M}\right)}{\frac{1}{2}} \quad \text{…..……… (5.7)}$$

$$PQXI_i = \frac{UV_i^X}{UV_i^X + UV_i^M} * \frac{2}{1} \quad \text{…..……… (5.8)}$$

$$PQXI_i = \frac{UV_i^X}{1} * \frac{2}{UV_i^X + UV_i^M} \quad \text{….……… (5.9)}$$

$$PQXI_i = \frac{UV_i^X}{\frac{UV_i^X + UV_i^M}{2}} \quad \text{…..……… (5.10)}$$

where,

$$\frac{UV_i^X + UV_i^M}{2} = \overline{UV_i} \quad \text{……….……… (5.11)}$$

$$PQXI_i = \frac{UV_i^X}{\overline{UV_i}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (5.12)$$

Similarly, PQMI (Appendix A1), *i.e.* the ratio of import unit value of the i^{th} product to average unit value of the i^{th} product is calculated as:

$$PQMI_i = \frac{UV_i^M}{\overline{UV_i}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

$$PQI = PQXI - PQMI \qquad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Substituting the values of PQXI and PQMI,

$$PQI = \frac{UV_i^X}{\overline{UV_i}} - \frac{UV_i^M}{\overline{UV_i}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (7.1)$$

$$PQI = \frac{UV_i^X - UV_i^M}{\overline{UV_i}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

To summarize the result at the section level, weights for PQI are assigned as below,

$$w_i = \frac{UV_i^X + UV_i^M}{\sum_{i=1}^{n}\left(UV^X + UV^M\right)} = \frac{UV_i{}^T}{\sum_{i=1}^{n} UV_i} \qquad \ldots\ldots\ldots\ldots\ldots (9)$$

Superscript T refers to total import and export unit values. Thus, the weighted PQI of i^{th} product takes the following form:

$$PQI_{wi} = PQI_i \frac{UV_i{}^T}{\sum_{i=1}^{n} UV_i} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (10)$$

From a home country perspective, IIT is classified as HIIT, if PQI value lies between (-) 1 to 1 *i.e.* $-1 \leq PQI \leq 1$ and VIIT otherwise. If the quality of export and import products is similar then unit values of such products are close to each other. In such cases PQI takes values either zero or close to zero and therefore product is classified as HIIT products. However, the difference between the export unit value and import unit value of such products can be greater than one or less than minus one due to many factors such as transportation cost, packaging, advertisement, outer look, market imperfections, tariff and other trade barriers, *etc*. If such difference is more than one then it is assumed that export quality of the product is different from the import quality, hence product is classified as VIIT. Thus, when the export unit value is higher than the import unit value by more than one, then PQI assumes value more than one. On the other hand, when the export unit value is lower than import unit value of the product by more than one, then PQI assumes values less than one. Therefore, if PQI varies from - 1 to 1 then products are grouped into HIIT.

Moreover, if exported and imported products are qualitatively different then difference between export unit value and import unit value is expected to be more than one. Thus, when value of PQI ranges (PQI $< (-1)$) and (PQI >1) it's known as VIIT. When export unit value is substantially lower than the import unit value, then the PQI value is between -1 to -2, and the product is classified as LVIIT product. On the other hand, when the export unit value is higher than the import unit value, the PQI is between 1 to 2, then, the product is considered as HVIIT product. In short, if PQI ranges from $-1 \leq \text{PQI} \leq -2$ it is considered as low quality vertically differentiated product (LVIIT) and if PQI scaled between $1 < \text{PQI} \leq 2$ then product is classified as HVIIT. Thus, on the basis of value of PQI IIT is classified into three parts LVIIT, HIIT and HVIIT such as $-2 \leq \text{LVIIT} < -1 \leq \text{HIIT} \leq 1 < \text{HVIIT} \leq 2$.

As mentioned in the review of literature the choice of dispersion limit is very important because the size of each type of IIT (HIIT, LVIIT and HVIIT) depends on it. Therefore, the modified PQI helps to distinguish IIT with a generalized methodology. The PQI ranges from -2 to 2. This total space within PQI is divided equally between HIIT and VIIT. In a nutshell, for the symmetrical distribution of total space in PQI (-2 to 2) the upper and lower limit for HIIT are set at 1 and -1 respectively. Thus, to maintain the proportionate segregation of IIT, the half of the total space (-1 to 1) is allotted for HIIT and remaining half of the -2 to 2 is allotted for VIIT. Within VIIT the space is equally allotted for LVIIT and HVIIT with symmetry. This can be explained with the hypothetical example given in Table 1. The unit value of export and import are given in column 2 and 3 respectively. Moreover, column 4 shows the ratio of export unit value of a product to its import unit value. Following the GHM, FF, AE and PQI indices, with the dispersion limit of 15 per cent, the products are classified into HIIT and VIIT ($VIIT^L$ and $VIIT^H$).

Table 1.: Hypothetical example to compare segregation of IIT using different indices

Unit Value of Product				GHM (15%)	FF (15%)	AE (15%)		PQI	
Product	**UV^X**	**UV^M**	**UV^x/UV^M**	**IIT**	**IIT**	**PQV**	**IIT**	**PQI**	**IIT**
A	0.000001	10	0.00	$VIIT^L$	$VIIT^L$	0.00	$VIIT^L$	-2.00	$VIIT^L$
B	1	10	0.10	$VIIT^L$	$VIIT^L$	0.18	$VIIT^L$	-1.64	$VIIT^L$
C	7	10	0.70	$VIIT^L$	$VIIT^L$	0.67	$VIIT^L$	-0.35	HIIT
D	7.2	10	0.72	$VIIT^L$	$VIIT^L$	0.82	$VIIT^L$	-0.33	HIIT
E	7.5	10	0.75	$VIIT^L$	$VIIT^L$	0.86	HIIT	-0.29	HIIT
F	8	10	0.80	$VIIT^L$	$VIIT^L$	0.89	HIIT	-0.22	HIIT
G	8.45	10	0.85	HIIT	$VIIT^L$	0.92	HIIT	-0.17	HIIT
H	8.72	10	0.87	HIIT	HIIT	0.93	HIIT	-0.14	HIIT
I	9.98	10	1.00	HIIT	HIIT	1.00	HIIT	0.00	HIIT
J	10	10	1.00	HIIT	HIIT	1.00	HIIT	0.00	HIIT
K	11	10	1.10	HIIT	HIIT	1.05	HIIT	0.10	HIIT
L	11.5	10	1.15	HIIT	HIIT	1.07	HIIT	0.14	HIIT
M	12.5	10	1.25	$VIIT^H$	$VIIT^H$	1.11	HIIT	0.22	HIIT
N	30	10	3.00	$VIIT^H$	$VIIT^H$	1.50	$VIIT^H$	1.00	HIIT
O	55	10	5.50	$VIIT^H$	$VIIT^H$	1.69	$VIIT^H$	1.38	$VIIT^H$
P	131	10	13.10	$VIIT^H$	$VIIT^H$	1.86	$VIIT^H$	1.72	$VIIT^H$
Q	261	10	26.10	$VIIT^H$	$VIIT^H$	1.93	$VIIT^H$	1.85	$VIIT^H$
R	622	10	62.20	$VIIT^H$	$VIIT^H$	1.97	$VIIT^H$	1.94	$VIIT^H$
S	1244	10	124.40	$VIIT^H$	$VIIT^H$	1.98	$VIIT^H$	1.97	$VIIT^H$
T	50000	10	5000.00	$VIIT^H$	$VIIT^H$	2.00	$VIIT^H$	2.00	$VIIT^H$

Source: Adapted from Azhar and Elliott, 2006; P.488.

Table 1 shows that, with the 15 per cent dispersion limit, the GHM index classifies IIT as $VIIT^L$ where the unit value ratio lies below 0.85, *i.e.* (1- α). Therefore, first six products are classified as $VIIT^L$. Moreover, FF index classifies IIT as $VIIT^L$ when the unit value ratio is less than 0.87, *i.e.* (1/ (1+α). Thus, the range for $VIIT^L$ products is slightly higher for FF index as compared to GHM. As a result the number of $VIIT^L$ products increased to seven. On the other hand, the upper range of dispersion limit is same for GHM and FF index that is 1.15, *i.e.* (1+ α). Therefore, number of $VIIT^H$ products remains same for both GHM and FF methods. The number of HIIT products increases in case of GHM index as it ranges from 0.85 to 1.15. On the other hand, the rage for HIIT products narrows down within 0.87 to 1.15 for FF index. As a result, number of HIIT products decreases in case of FF index as compared to GHM.

The segregation of IIT is based on value of PQV and PQH in the AE index. When the value of PQV index is below 0.85 the product is considered as $VIIT^L$. As per the above numerical example, only four products are classified as the $VIIT^L$. Thus, it can be deduced that following the same dispersion limit of 15 per cent the proportion of $VIIT^L$ products narrows down in AE method. On the other hand, proportion of HIIT products increased in the AE index as compared to GHM and FF indices. In all these indices, it is assumed that in the existence of transport cost and imperfect markets the unit value of export and import varies. Thus, the major problem of these indices lies with the selection of dispersion limit. Although, the 15 per cent dispersion limit is same for GHM, FF and AE methods the number of products in HIIT and VIIT differs. All the three indices lead to upward bias in the measurement of VIIT. In case of GHM index only 6 products are classified as HIIT products and remaining 14 products are classified as VIIT. Moreover, only 5 products are classified as HIIT and 15 products are classified as VIIT by following FF method. Furthermore, 9 products are classified as HIIT out of 20 products for AE method. The high number of VIIT products is because of unequal classification of IIT into HIIT and VIIT. With the 15 per cent dispersion limit used in GHM, FF and AE methods, the space for HIIT narrows down as compared to VIIT. It leads to upward (downward) bias in the measurement of VIIT (HIIT). Following the PQI, 12 out of 20 products are classified as HIIT and remaining are VIIT. The total space of PQI (-2 to 2) is equally distributed between HIIT (50 per cent) and VIIT (50 per cent). The PQI helps to remove this bias following the equal space for HIIT and VIIT products.

Furthermore, it also raises the question such as to why the dispersion limit is set at 15 per cent. The various studies also found that 15 per cent dispersion limit is too narrow to classify the IIT. Instead of 15 per cent, studies have tried with 25 per cent as a dispersion limit. The classification of IIT is very sensitive to the selection of dispersion limit. If the dispersion limit varies from 15 per cent to 25 or to 5 per cent, the classification of IIT changes significantly. The selection in the dispersion limit creates the vagueness in the classification of IIT. On the other hand, the use of PQI index assists to solve this problem. In case of PQI, it does not depend on any arbitrary value of dispersion limit. Hence, it removes the arbitrariness in the segregation of IIT with equal space.

The second drawback in proposed GHM, FF and AE methods is related to unequal distribution (bias) of IIT into HIIT and VIIT. All the three indices lead to asymmetric distribution of IIT into HIIT and VIIT. There is no upper and lower limit to the ratio of export unit value to its import unit value for GHM and FF methods (Table 1). Thus, with arbitrary selection of dispersion limit, say 15 per cent lead to asymmetric classification of IIT into HIIT and VIIT. If the total range of IIT products is consider as one, then, with 15 per cent dispersion limit, the range for HIIT products narrow downs to 15 per cent of the total range.

Although, the lower and upper limit in AE method is defined as 0 and 2 respectively, the asymmetry in the upper and lower bound leads to unequal classification of IIT (Figure 1A). As per the AE method, the total product quality space ranges from 0 to 2. With the cut-off point of 85 per cent, the lower and upper limit of 0.85 and 1.15 respectively, are used to segregate IIT (Azhar and Elliott, 2006). Thus, the space for HIIT is equal to 15 per cent and for VIIT is 85 per cent of the total space. This leads to upward (downward) bias in the measurement of VIIT (HIIT).

As the total array for PQI is symmetrically distributed as compared to AE method, it helps to classify IIT more symmetrically (Figure 1B). By construction the lower and upper bound for PQI is defined at -2 and 2 respectively. To maintain the symmetry between classifications of IIT the lower and upper bound for HIIT products are set at -1 and 1respectively and for VIIT from -1 to -2 and 1 to 2. Thus, HIIT and VIIT get equal space in the total space of -2 to 2 in figure 1B. Furthermore, the space for VIIT is also equally allotted between $VIIT^{L}$ (-1 to -2) and $VIIT^{H}$ (1 to 2). In brief there is no bias in segregating IIT at any level.

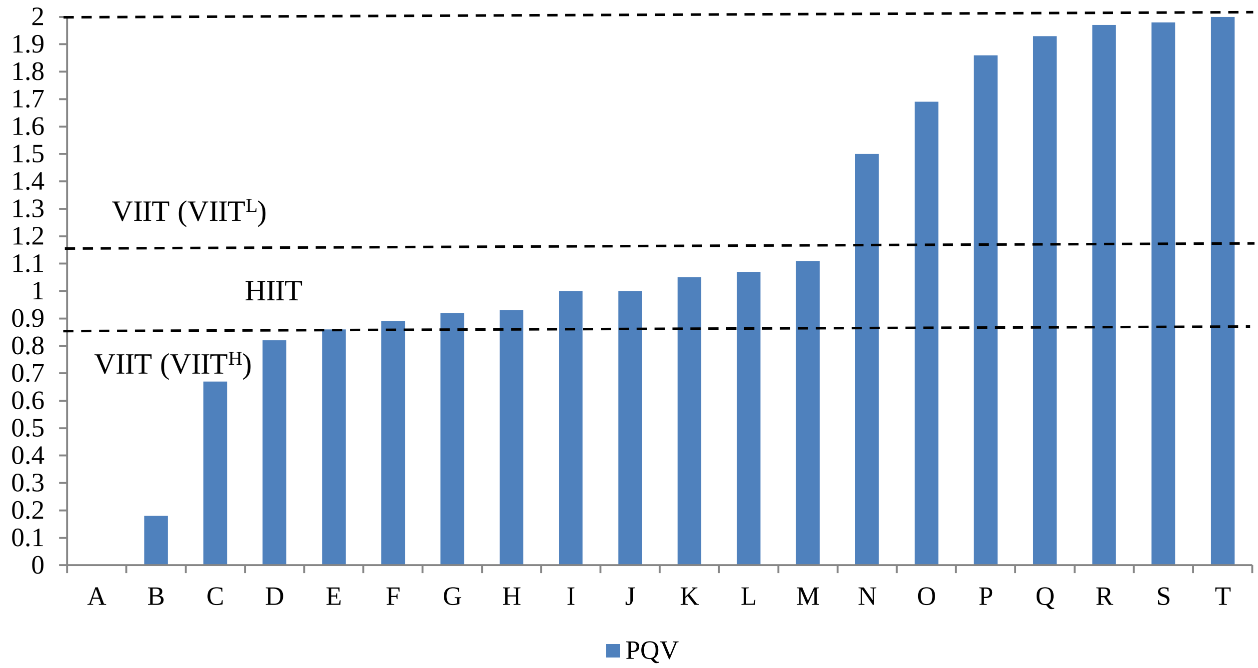

Figure 1A.: Classification of IIT as per AE index

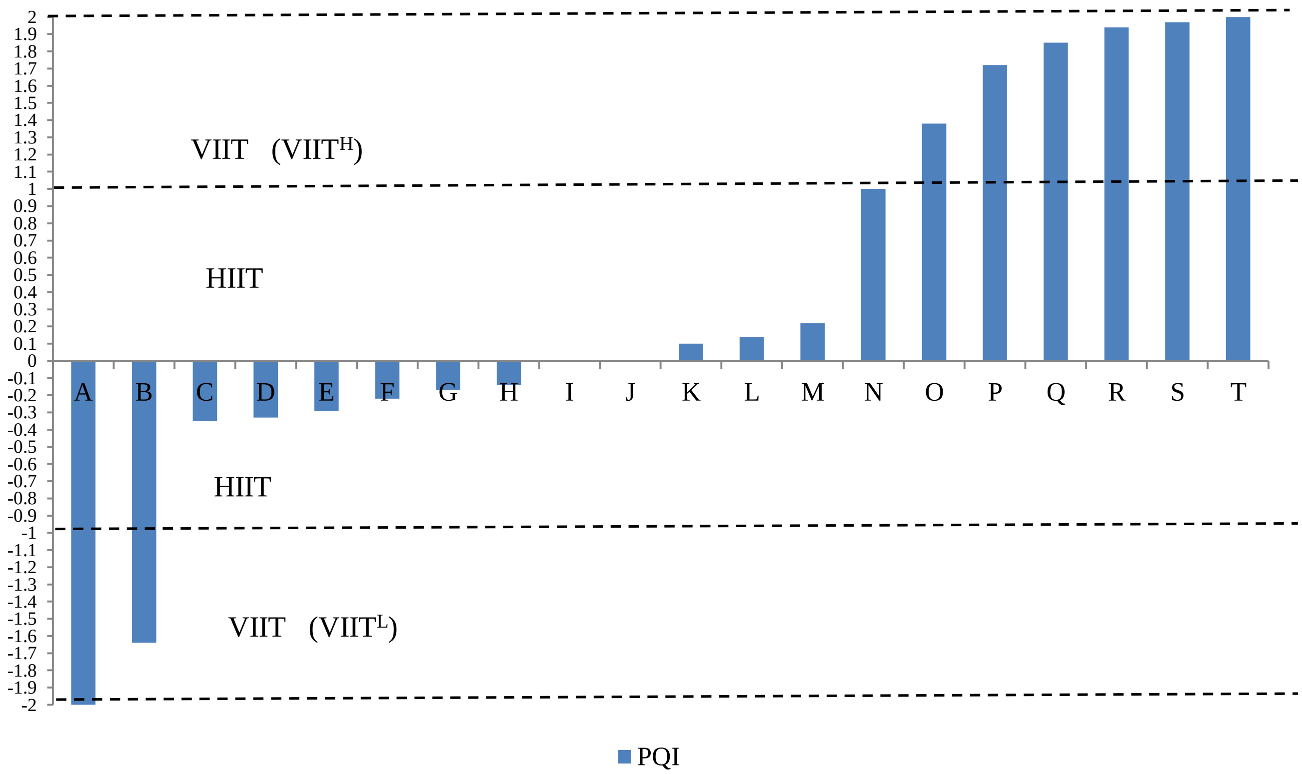

Figure 1B.: Classification of IIT as per PQI

4. COMPARATIVE ANALYSIS OF IIT OF INDIA:

For the empirical assessment of PQI, the India's foreign trade data is used at the most disaggregated level. As per HS classification, 8-digit product code is used to measure the IIT. On the basis of unit value measurement, the GL index (IIT) is decomposed into HIIT and VIIT. The comparison between GHM, FF, AE and PQI is provided in this section. The basic notion behind the segregation of IIT is that the high-quality products are traded at higher price. It is important to observe the change in the composition of IIT with each of these (GHM, FF, AE and PQI) indices. Table 2 shows the classifications of IIT index into HIIT and VIIT. Following the GHM, FF, AE and PQI, IIT is estimated for the period 1991-91 to 2015-16. The figures in the bracket show the percentage share of IIT index. The first column represents the Index of India's IIT which shows an increasing trend with the CAGR of 5.58 per cent during the period of study. Following the dispersion limit of 15 per cent, the IIT is segregated into HIIT and VIIT as per the GHM, FF, AE indices. Following the GHM method, at 15 per cent dispersion limit, the total IIT is dominated by VIIT (5.36) in the year 1990-91. Similar trend is continuing till 2015-2016. Within VIIT, the contribution of LVIIT is more than HVIIT during 1990-91 to 2015-16. In percentage term, share of VIIT is 82.84 per cent in 1990-91 which is decreased to 72.59 per cent in 2015-16. Similarly, for FF method as well the dominance of VIIT remains constant. Following the AE method, the share of HIIT and VIIT is 23.80, 76.20 respectively in 1990-91. The dominance of VIIT remains continued till the year 2015-16. Within VIIT, the share of LVIIT is more as compared to HVIIT for all the three indices. It can be notice that the share of VIIT is decelerating while that of HIIT is increasing in all the three indices as a result the CAGR of HIIT is more as compared to the VIIT during 1990-91 to 2015- 16. However, the dominance of VIIT in GHM, FF and AE indices are due to unequal segregation of IIT which leads to upward bias in the measurement of VIIT. Thus, the empirical studies pertaining to classification of IIT found the dominance of VIIT in the IIT.

On the other hand, following the PQI, the equal segregation of IIT into HIIT and VIIT leads to increase in HIIT. As a result the share of HIIT is 59.51 per cent while that of VIIT is 40.49 per cent in 1990-91. The share of HIIT increased to 82.25 per cent while share of VIIT decreased to 17.25 per cent in the year 2015-16.

Table 2.: Comparative analysis of Segregation of IIT index using Different indices

Year	IIT	GHM-15				FF-15				AE-15				PQI			
		HIIT	VIIT			HIIT	VIIT			HIIT	VIIT			HIIT	VIIT		
			VIIT	LVIIT	HVIIT		VIIT	LVIIT	HVIIT		VIIT	LVIIT	HVIIT		VIIT	LVIIT	HVIIT
1990-91	**6.47 (100)**	1.11 (17.15)	5.36 (82.85)	4.32 (80.60)	1.04 (19.40)	1.09 (16.85)	5.38 (83.15)	4.34 (80.67)	1.04 (19.34)	1.54 (23.80)	4.93 (76.20)	4.12 (83.57)	0.81 (16.43)	3.85 (59.51)	2.62 (40.49)	2.39 (91.23)	0.23 (8.77)
1991-92	**5.85 (100)**	0.62 (10.60)	5.23 (89.40)	4.23 (80.88)	1.00 (19.12)	0.58 (9.91)	5.27 (90.09)	4.27 (81.03)	1.00 (18.98)	1.06 (18.11)	4.79 (81.89)	4.03 (84.13)	0.76 (15.87)	3.14 (53.68)	2.71 (46.32)	2.46 (90.78)	0.25 (9.22)
1992-93	**6.46 (100)**	0.90 (13.93)	5.56 (86.07)	4.66 (83.81)	0.90 (16.19)	0.78 (12.08)	5.68 (87.92)	4.78 (84.16)	0.90 (15.85)	1.33 (20.58)	5.13 (79.42)	4.38 (85.38)	0.75 (14.62)	3.36 (52.01)	3.10 (47.99)	2.87 (92.59)	0.23 (7.421)
1993-94	**7.28 (100)**	0.76 (10.43)	6.52 (89.57)	4.89 (75.00)	1.63 (25.00)	0.71 (10.74)	6.57 (90.26)	4.94 (75.2)	1.63 (24.81)	1.87 (25.68)	5.41 (74.32)	4.57 (84.47)	0.84 (15.53)	4.13 (56.73)	3.15 (43.27)	2.90 (92.07)	0.25 (7.93)
1994-95	**8.36 (100)**	1.01 (11.98)	7.35 (87.92)	5.38 (73.20)	1.97 (26.80)	0.98 (11.72)	7.38 (88.28)	5.41 (73.31)	1.97 (26.7)	1.95 (23.32)	6.41 (76.68)	4.71 (73.47)	1.70 (26.53)	5.54 (66.26)	2.82 (33.74)	2.43 (86.18)	0.39 (13.82)
1995-96	**8.92 (100)**	1.50 (16.81)	7.42 (83.19)	5.35 (72.10)	2.07 (27.80)	1.40 (15.70)	7.52 (84.30)	5.45 (72.48)	2.07 (27.53)	2.34 (26.23)	6.58 (73.77)	4.79 (72.80)	1.79 (27.20)	6.09 (68.27)	2.83 (31.73)	2.44 (86.22)	0.39 (13.78)
1996-97	**9.67 (100)**	1.72 (17.79)	7.95 (82.21)	5.66 (71.20)	2.29 (28.80)	1.66 (17.17)	8.01 (82.83)	5.72 (71.42)	2.29 (28.59)	2.61 (27.00)	7.06 (73.00)	5.10 (72.23)	1.96 (27.77)	6.49 (67.11)	3.18 (32.89)	2.74 (86.17)	0.44 (13.83)
1997-98	**10.95 (100)**	1.49 (13.61)	9.46 (86.49)	6.03 (63.75)	3.43 (36.25)	1.36 (12.42)	9.59 (87.58)	6.16 (64.24)	3.43 (35.77)	2.36 (21.55)	8.59 (78.45)	5.64 (65.65)	2.95 (34.35)	7.07 (64.56)	3.88 (35.44)	2.87 (73.97)	1.01 (26.03)
1998-99	**10.09 (100)**	1.09 (10.81)	9.00 (89.29)	5.85 (65.00)	3.15 (35.00)	1.05 (10.40)	9.04 (89.60)	5.89 (65.16)	3.15 (34.85)	2.05 (20.31)	8.04 (79.69)	5.39 (67.03)	2.65 (32.97)	6.14 (60.85)	3.95 (39.15)	2.82 (71.40)	1.13 (28.60)
1999-00	**10.76 (100)**	1.51 (14.04)	9.25 (85.96)	5.69 (61.52)	3.56 (38.48)	1.35 (12.55)	9.41 (87.45)	5.85 (62.17)	3.56 (37.84)	2.49 (23.14)	8.27 (76.86)	5.08 (61.42)	3.19 (38.58)	6.74 (62.63)	4.02 (37.37)	2.47 (61.45)	1.55 (38.55)
2000-01	**11.50 (100)**	1.49 (12.96)	10.01 (87.04)	6.08 (60.73)	3.93 (39.27)	1.40 (12.27)	10.10 (87.83)	6.17 (61.09)	3.93 (38.92)	2.57 (22.34)	8.93 (77.66)	5.52 (61.81)	3.41 (38.19)	8.03 (69.82)	3.47 (30.18)	2.43 (70.03)	1.04 (29.97)
2001-02	**12.54 (100)**	1.39 (11.09)	11.15 (88.91)	7.03 (63.05)	4.12 (36.95)	1.24 (9.89)	11.30 (90.11)	7.18 (63.54)	4.12 (36.47)	3.19 (25.43)	9.35 (74.57)	5.95 (63.63)	3.40 (36.37)	8.87 (70.73)	3.67 (29.27)	2.54 (69.20)	1.13 (30.80)
2002-03	**12.67 (100)**	2.02 (15.95)	10.65 (84.05)	6.58 (61.79)	4.07 (38.21)	1.86 (14.68)	10.81 (85.32)	6.74 (62.35)	4.07 (37.66)	3.45 (27.22)	9.22 (72.78)	5.88 (63.77)	3.34 (36.23)	8.71 (68.74)	3.96 (31.26)	2.96 (74.75)	1.00 (25.25)
2003-04	**15.26 (100)**	2.31 (15.14)	12.95 (84.86)	7.82 (60.39)	5.13 (39.61)	2.23 (14.61)	13.03 (85.39)	7.90 (60.63)	5.13 (39.38)	3.76 (24.63)	11.50 (75.37)	6.97 (60.60)	4.53 (39.40)	10.57 (69.26)	4.69 (30.74)	3.37 (71.85)	1.32 (28.15)
2004-05	**16.15 (100)**	2.64 (16.35)	13.51 (83.65)	7.43 (55.00)	6.08 (45.00)	2.49 (15.41)	13.66 (84.59)	7.58 (55.5)	6.08 (44.51)	4.06 (25.13)	12.09 (74.87)	6.69 (55.33)	5.41 (44.67)	12.13 (75.10)	4.02 (24.90)	3.27 (81.35)	0.75 (18.65)
2005-06	**16.13 (100)**	3.09 (19.15)	13.04 (80.85)	7.62 (58.43)	5.42 (41.57)	2.80 (17.94)	13.23 (82.06)	7.81 (59.04)	5.42 (40.97)	4.75 (29.45)	11.38 (70.55)	6.72 (59.05)	4.66 (40.95)	12.42 (77.00)	3.71 (23.00)	2.83 (76.29)	0.88 (23.71)
2006-07	**18.07 (100)**	5.25 (29.06)	12.82 (70.94)	8.28 (64.59)	4.54 (35.41)	5.10 (28.23)	12.97 (71.77)	8.43 (65)	4.54 (35.01)	7.47 (41.34)	10.60 (58.66)	6.75 (63.67)	3.85 (36.33)	14.01 (77.53)	4.06 (22.47)	2.93 (72.17)	1.13 (27.83)
2007-08	**19.04 (100)**	6.25 (32.82)	12.79 (67.18)	7.87 (61.53)	4.92 (38.47)	6.12 (32.15)	12.92 (67.85)	8.00 (61.92)	4.92 (38.09)	8.96 (47.05)	10.08 (52.95)	6.12 (60.72)	3.96 (39.29)	15.71 (82.51)	3.33 (17.49)	1.92 (57.65)	1.41 (42.35)
2008-09	**23.55 (100)**	5.56 (23.60)	17.99 (76.40)	9.55 (53.09)	8.44 (46.91)	5.07 (21.52)	18.48 (78.48)	10.04 (54.33)	8.44 (45.68)	8.12 (34.47)	15.43 (65.53)	7.88 (51.07)	7.55 (48.94)	19.07 (80.97)	4.48 (19.03)	2.66 (59.38)	1.82 (40.62)
2009-10	**20.16 (100)**	7.97 (39.53)	12.19 (60.47)	7.66 (62.83)	4.53 (37.17)	7.30 (36.21)	12.86 (63.79)	8.33 (64.78)	4.53 (35.23)	9.32 (46.23)	10.84 (53.77)	7.01 (64.66)	3.83 (35.34)	15.06 (74.70)	5.10 (25.30)	3.04 (59.60)	2.06 (40.40)
2010-11	**22.92 (100)**	10.27 (44.80)	12.65 (55.20)	8.14 (64.35)	4.51 (35.65)	10.17 (44.45)	12.75 (55.65)	8.24 (64.63)	4.51 (35.38)	12.49 (54.50)	10.43 (45.50)	6.91 (66.25)	3.52 (33.75)	18.93 (82.60)	3.99 (17.40)	2.69 (67.42)	1.30 (32.58)
2011-12	**19.36 (100)**	3.95 (20.40)	15.41 (79.60)	8.25 (53.53)	7.16 (46.47)	3.26 (16.83)	16.10 (83.17)	8.94 (55.53)	7.16 (44.48)	6.00 (31.09)	13.36 (69.01)	7.08 (53.00)	6.28 (47.00)	15.93 (82.29)	3.43 (17.71)	2.51 (73.18)	0.92 (26.82)
2012-13	**20.11 (100)**	5.48 (27.26)	14.64 (72.74)	9.28 (63.39)	5.36 (36.61)	4.53 (22.52)	15.58 (77.48)	10.22 (65.6)	5.36 (34.41)	7.94 (39.48)	12.17 (60.52)	7.49 (61.55)	4.68 (38.45)	15.85 (78.81)	4.26 (21.19)	3.29 (77.24)	0.97 (22.76)
2013-14	**19.38 (100)**	6.53 (33.64)	12.86 (66.36)	8.93 (69.45)	3.93 (30.55)	6.37 (32.86)	13.01 (67.14)	9.08 (69.8)	3.94 (30.21)	8.74 (45.10)	10.64 (54.90)	7.38 (69.37)	3.26 (30.63)	15.49 (79.92)	3.89 (20.08)	2.73 (70.18)	1.16 (29.82)
2014-15	**19.59 (100)**	4.64 (23.69)	14.95 (76.31)	9.35 (62.55)	5.60 (37.46)	4.25 (21.74)	15.34 (78.26)	9.73 (63.48)	5.61 (36.53)	7.14 (36.44)	12.45 (63.56)	7.78 (62.49)	4.67 (37.51)	15.65 (79.89)	3.94 (20.11)	2.71 (68.79)	1.23 (31.21)
2015-16	**21.74 (100)**	5.96 (27.41)	15.78 (72.59)	9.84 (62.35)	5.94 (37.65)	5.87 (27.00)	15.87 (73.00)	9.93 (62.58)	5.94 (37.43)	8.72 (40.11)	13.02 (59.89)	8.15 (62.60)	4.87 (37.40)	17.88 (82.25)	3.86 (17.75)	2.24 (58.04)	1.62 (41.96)
CAGR (%)	**5.58**	**10.21**	**4.36**	**3.26**	**7.00**	**10.11**	**4.46**	**3.43**	**7.00**	**9.05**	**3.99**	**2.68**	**7.43**	**7.32**	**1.53**	**0.13**	**7.16**

As a result, the CAGR of HIIT and VIIT is 7.32 and 1.53 per cent respectively for the period 1990-91 to 2015-16. The proportionate segregation of IIT under PQI leads to remove downward bias in the measurement of HIIT.

5. CONCLUSIONS:

The methodological development related to the segregation of IIT built on the contribution by GHM, FF and AE methods. The paper provides the detailed comparison of these three methods including their pros and cons. Although, GHM and FF are having the similar properties to segregate IIT but the differences lie in the construction of indices. Therefore, with the same dispersion limit, the range for LVIIT products is higher for FF method as compared to GHM method. Both GHM and FF methods use ratio of unit value of export to unit value of import to segregate IIT. There is no upper and lower limit for the ratio of unit value of export to unit value of import which leads to unequal classification of IIT. Although, the AE method estimated the IIT with the lower and upper bound, the asymmetry between the lower and upper limit leads to unequal division of space between HIIT and VIIT. The PQI help to maintain the equal classification of IIT into HIIT and VIIT. Thus, estimation of IIT through PQI helps to remove upward bias in the measurement of VIIT as it gives equal weight to HIIT and VIIT prior to empirical assessment. It is the nature of country’s IIT which plays the crucial role in deciding share of each type of IIT (HIIT and VIIT). In this way PQI helps to minimise the upward (downward) bias in the measurement of VIIT (HIIT).

All the three methods are based on the choice of dispersion limit to segregate IIT. Since, the selection of dispersion limit is arbitrary, the slight change in the dispersion limit leads to change in the segregation of IIT. It creates the ambiguity in the empirical assessment. Thus, to overcome this problem, the product quality index *i.e.*, PQI is developed. PQI does not require the arbitrary selection of dispersion limit. The comparative analysis between PQI and other three methods highlight the fact that PQI is simple to estimate and also country neutral. It provides equal space between HIIT and VIIT and also with LVIIT and HVIIT within VIIT.

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APPENDIX A

APPENDIX A.1

Similar to PQXI, the construction of PQMI is given as:

$$PQMI_i = 1- \frac{UV_i^X - UV_i^M}{UV_i^X + UV_i^M} \quad \text{…..…………} \quad (A1.1)$$

$$PQMI_i = \frac{UV_i^X + UV_i^M - \left(UV_i^X - UV_i^M\right)}{UV_i^X + UV_i^M} \quad \text{…..…………} \quad (A1.2)$$

$$PQMI_i = \frac{UV_i^X + UV_i^M - UV_i^X + UV_i^M}{UV_i^X + UV_i^M} \quad \text{…..…………} \quad (A1.3)$$

$$PQMI_i = \frac{UV_i^M + UV_i^M}{UV_i^X + UV_i^M} \quad \text{…..…………} \quad (A1.4)$$

$$PQMI_i = \frac{2UV_i^M}{UV_i^X + UV_i^M} \quad \text{…..…………} \quad (A1.5)$$

$$PQMI_i = 2\left(\frac{UV_i^M}{UV_i^X + UV_i^M}\right) \quad \text{…..…………} \quad (A1.6)$$

$$PQMI_i = \frac{2}{1} * \left(\frac{UV_i^M}{UV_i^X + UV_i^M}\right) \quad \text{…..…………} \quad (A1.7)$$

$$PQMI_i = \frac{\left(\frac{UV_i^M}{UV_i^X + UV_i^M}\right)}{\frac{1}{2}} \quad \text{…..…………} \quad (A1.8)$$

$$PQMI_i = \frac{UV_i^M}{UV_i^X + UV_i^M} * \frac{2}{1} \quad \text{…..…………} \quad (A1.9)$$

$$PQMI_i = \frac{UV_i^M}{1} * \frac{2}{UV_i^X + UV_i^M} \quad \text{…..…………} \quad (A1.10)$$

$$PQMI_i = \frac{UV_i^M}{\frac{UV_i^X + UV_i^M}{2}} \quad \text{…..…………} \quad (A1.11)$$

where,

$$\frac{UV_i^X + UV_i^M}{2} = \overline{UV_i} \qquad \text{.....................(A1.12)}$$

$$PQMI_i = \frac{UV_i^M}{\overline{UV_i}} \qquad \text{.................. (A1.13)}$$

Thus, PQMI *i.e.* the ratio of import unit value of the i^{th} product to average unit value of the i^{th} product.

Published by:

ISF INSTITUTE OF RESEARCH AND EDUCATION
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