Beyond the Conventional:
A Modified Approach to CARICOM's Intra-Industry Trade

Draft Paper for Discussion only

Roger Hosein[1], Christina Baptiste[2], George Saridakis[3]

[1]Trade and Economic Development Unit, Department of Economics, University of the West Indies, St. Augustine, Trinidad and Tobago (corresponding author: Roger.Hosein@sta.uwi.edu)

[2]University of the West Indies, St. Augustine, Trinidad and Tobago.

[3]Kent University, Business School, Canterbury, UK

The Caribbean Community (CARICOM) has significantly boosted its member countries regional and international trade. However, the phenomenon of Intra-Industry Trade (IIT), where countries export and import goods within the same industry, is particularly relevant to CARICOM trade. This paper analyses CARICOM's IIT using a modified methodology based on the Hosein-Seecharan (HS) Index. The modification includes bilateral and unilateral trade flows, reducing false IIT captures. By correcting trade imbalances and comparing different levels of categorical aggregation, the study found minimal bias. The modified IIT calculation has practical policy implications, encouraging deeper CARICOM IIT through industry-specific research and initiatives.

Jel Classification: C8, F12, F14

Key Words: Intra-Industry Trade (IIT); Measurement of IIT; Trade Imbalance; Categorical Aggregation; Modified Index; CARICOM Trade.

1. Introduction

Intra-Industry Trade (IIT) is an observed phenomenon that is defined most popularly as "*trade in differentiated products which are close substitutes*" (Grubel and Llyod, 1975, 1). Finger (1975) in an Economic Inquiry Journal, argued that the theory of IIT is an entirely statistical outcome due to the groupings of traded goods while researchers such as Krugman (1979) reasoned that its distinctive growth in total trade warrants further analysis. Essentially, IIT ensues when a country exports and imports goods (two-way trade) in the same industry which means that they are importing and exporting similar products (Ruffin, 1999). For example, IIT occurred when European countries imported wheat from the United States of America and exported wheat to developing countries (Södersten and Reed, 1994). Contrastingly, IIT occurs in one-way trade when a country exports (imports) goods in unrelated industries to (from) another country, such as exporting machines (importing textiles).

Today, technological, and industrial advancements have not only increased the international trade of products and services, but also increased trade competition between developed and developing countries (IMF Staff, 2001). One can imagine that as competition increases, a country may experience an economic downturn due to falling demand for the country's exports. As such, the ability for the country to maintain a sustainable level of export revenue becomes increasingly difficult (Wilen, 2022). This is one of the many reasons why countries may have to consider the exact make-up of their import-export market and align trade to maximize their resources within predisposed constraints. One such phenomena that can assist countries in examining their trade market is the theory of IIT since it aims to capture trade of differentiated goods that are close substitutes (Grubel and Llyod, 1975, 1). This would help by exporting waste and materials to countries where there is a revealed advantage in sorting and processing waste rather than establishing a waste management company from the ground-up, for example (Yamaguchi, 2018).

Furthermore, noting the organised empirical work on intra-industry trade by Grubel and Lloyd, 1975 and Greenaway and Milner, 1986, Anderson et. al (2016) explored intra-industry trade in the wine industry and anticipated that some wine varieties would become more preferred in developed countries and thus result in intra-industry trade. They found that network topology methods and the established measures of IIT provide a good basis managing IIT and its development especially for products with large variations. Moreover, to better manage a country's IIT levels, the first step is to accurately measure IIT. While there has been significant progress in measuring IIT levels, there still exists some methodological concerns

that are currently being addressed by researchers such as Hayakawa et al and Mukerji and Panagariya, among others.

When we examine the phenomenon of IIT in comparison to traditional international trade theories, a few interesting events occur. It is not in line with Ricardo's (1817) well-known Theory of Comparative Advantage which states that a country will earn through exporting goods in which they have a lower opportunity cost to produce and therefore specialise in that good. Under Ricardo's theory, there is no justification for IIT since countries would theoretically be involved in perfect IIT if pure specialization were to occur. In other words, pure specialisation occurs where countries would trade only that which they have a smaller opportunity cost to produce resulting in perfect IIT, which means that for good *i*, exports exactly equal imports. This does not hold in reality as many countries may still trade goods even if they do not have a comparative advantage due to factors such as consumer preferences/tastes. Notably though is the work of Weder (1995), who proposed a link between absolute and comparative advantage to IIT theory. He found that every country is a net exporter of the group in which its domestic demand is larger (i.e. a comparative home-market advantage) and that absolute variations in demand influence relative salaries. From this link, one can infer that IIT theory has significant explanatory power when it comes to understanding trade flows, which will be further explored in this paper.

Ottaviano et. al (2009), further noted that IIT arises because customers enjoy variety, but countries can generate only a few varieties as it is dependent on their size. In another journal, Venables et. al (1985) noted that imperfect competition fosters IIT as companies believe it is lucrative to enter markets even if they do not have a comparative advantage. Venables et. al elaborated that the traditional view of international trade can co-exist with imperfect competition and the magnitude of IIT which is contingent on the countries' size and factor endowments. This demonstrates the significance of IIT levels especially in today's competitive economic world.

In addition, IIT is not in line with Heckscher-Ohlin's (H-O) Theory (Factor Proportions Model) which states that a country with surplus capital will sell the capital-intensive product to foreign markets and import the labour-intensive product (Suranovic, 2012). However, under H-O, countries may still produce both capital intensive and labour-intensive goods causing trade imbalances, as countries do not export only that which uses its scarce resources. Therefore H-O theory may not always hold in reality. Further, in an economic policy journal, Neven et.

al (1990) examined how integration would be beneficial to the European Economic Community towards 1992 considering the impending policy decisions on European Integration during the period. Using the Grubel-Lloyd IIT Index, Neven et. al found that Southern European countries would be the main beneficiaries who would gain from unexploited labour-intensive products since Northen European countries already had exploited its gains. The measurement of IIT therefore can be used as an indicator of market-makeup and potential areas for future gains. Moreover, when looking at IIT, it can be further broken down into Horizontal IIT (Horizontal Product Differentiation) which occurs in trade of products with different varieties but similar qualities and Vertical IIT (Vertical Product Differentiation) which is trade in products with different varieties and different qualities (Greenaway, Hine and Milner, 1995).

Greenaway and Milner (1987) presented an evaluation of earlier IIT research via four main lens: (i) Theory - general/partial equilibrium models and variations of imperfect competition models; (ii) Measurement - static indices (IIT at a single timestamp) and dynamic indices (IIT over time) for which the Grubel and Lloyd's (GL) static index is the most common; (iii) Empirical Evidence - use of mathematical measurement indices of IIT versus use of econometric techniques to capture IIT industry differences; and (iv) Policy Aspects - whether the gains from IIT differ from Inter-Industry Trade and whether intervention of trade flows can benefit an economy. Thus, Greenaway and Milner's evaluation acts as a framework to guide modern IIT research.

Hence, this paper focuses on lens (ii) above, the measurement of IIT, as it is a key building block for cultivating strong IIT policy recommendations. As such, this paper reviews the established methodologies in calculating IIT with particular focus on the merits and associated concerns of the static and dynamic indices. Following which, an account of the many adjustments/corrections to the measurements of IIT is also conducted in relation to two key measurement issues highlighted by Greenaway and Milner (1987), accounting for trade imbalances and categorical aggregation bias. Upon careful analysis of the established methodologies and the associated adjustments/corrections, a modified methodology is proposed in the context of CARICOM's IIT levels.

The modification in this paper adds to the wealth of existing literature on IIT as it includes both bilateral and unilateral trade flows to offer a more balanced examination of trade flows. Also, the modification quantifies whether the level of aggregation (aggregation bias) has any impact on the amount of IIT that exists by using a comparison on two levels of aggregation.

It further considers trade imbalances on the industry level, through a simple procedure to separate two conditions among the varying industries (where $X<M$ and $X>M$). The results are then presented via the use of a sample scenario as well as applied to the case of CARICOM's IIT and policy recommendations are formulated based on findings.

This paper is structured as follows: Section 2 reviews the established static and dynamic measures of IIT and highlights the main concerns with these indices. A review of the many adjustments/corrections to the measurements of IIT follows, supporting the call for further modifications when examining IIT levels. Section 3 provides the proposed modified methodology of IIT. Section 4 presents the improvements made by the modification and provides and overview of the differences between the established methodologies and the modified index. Section 5 presents the results of the modified index via a sample scenario as well as provided results on accounting for trade imbalances and the proposed categorical aggregation procedure. Section 6 concludes the paper and presents policy implications, limitations, and directions for future research.

2. Assessing and Refining Established Methodologies

In this section, we present an overview of the established methodologies for calculating IIT such as the Grubel-Lloyd Index, the Brülhart Index and the Hosein-Seecharan Index. However, for a detailed analysis of the predominant methodologies employed to measure Intra-Industry Trade, refer to Hosein-Seecharan (2013). We first review the established static and dynamic measures of IIT, by presenting the main formula and assessing the merits and drawbacks of each index. The main concerns with these indices are summarised and explained concisely. Following which, a review of the many adjustments/corrections to the measurements of IIT is provided, supporting the notion that further modifications are needed to better examine IIT levels.

2.1. Grubel-Lloyd (GL) Index

Grubel and Lloyd (1971 and 1975) examined trade data and noticed an increasing number of exports and imports fitting into the same industry were being traded. They proposed the following index that became popular as the Grubel-Lloyd index which captured the degree to whether the export quantity (X_i) matched the import quantity (M_i) for a given $good_i$ (trade overlap) at one point in time, and then divided by total trade as follows:

$$GL_i = \frac{(X_i + M_i) - |X_i + M_i|}{X_i + M_i} = 1 - \frac{|X_i - M_i|}{X_i + M_i} \quad ; 0 \leq GL_i \leq 1 \tag{1}$$

The index ranges from 0 (full inter-industry trade) to 1 (full intra-industry trade).

Within the past 5 decades, there have been adjustments/improvements to the GL's index mainly: to include international supply (*g*) in terms of domestically produced products (mode 1) and foreign products (mode 2) (Lloyd, 1998); to account for sectorial competitiveness (HM_j index) which ranges from 1 (more competitive as $X > M$) to -1 (less competitive as $X < M$) (Mercan and Yergin, 2012); and to approximate the "intensity" of IIT for a commodity group experiencing bilateral trade flows by calculating an average GL index and dividing it by the number of commodities traded (Boring, 2012). However, the most significant drawbacks of the GL index concern issues with categorical aggregation bias, accounting for trade imbalances and its inability to capture changes in trade flows (Brülhart, 2002).

2.2. Brülhart's 'A' Index / Marginal Intra-Industry Trade (MIIT)

Brülhart's (1994) 'A' index aimed to capture dynamic changes in trade flows over time, where it measured the difference between export quantity (X_i) at time (t) and at time t-n (X_i(t-n)), and import quantities (M_i) at time (t) and M_i(t-n) as follows:

$$MIIT_i = 1 - \frac{|(X_{i(t)} - X_{i(t-n)}) - (M_{i(t)} - M_{i(t-n)})|}{(|X_{i(t)} - X_{i(t-n)}| + |M_{i(t)} - M_{i(t-n)}|)} = 1 - \frac{|\Delta X - \Delta M|}{|\Delta X| + |\Delta M|} \quad ; \quad 0 \leq MIIT_i \leq 1 \qquad (2)$$

MIIT results ranges from 0 (marginal inter-industry trade) to 1 (marginal intra-industry trade).

However, Brülhart's 'A' index was criticized by Dixon and Menon (1997) as they found that it did not capture the change associated with adjustment costs, i.e. marginal inter-industry trade. In this regard, there have been some adjustments to the 'A' index for example, to account for the difference between the initial value of trade flows versus the n^{th} year between two partners (A^r Index) (Brülhart and Hine, 1999). Among other adjustments/modifications, Brülhart introduced his 'B' index to correct for 'A' which did not capture sectoral trading patterns. The B index therefore looked at the asymmetry between the growth of net exports and imports of an industry since it was not proper to assume balanced adjustment costs for job formation and job loss in any industry. The results of the B index ranged from -1 to 1 where closer to 0 indicates MIIT and closer to -1 or 1 indicates marginal inter-industry trade. It provides a sign of which sectors were specialised into/specialised out of and it was also modified like the A^r index to examine initial trade levels. However, the 'B' index cannot be combined across industries as it would result in higher IIT levels. The 'B' index is also non-receptive to variations in exports and imports (Azhar and Elliot, 2003). Brülhart made further

adjustments with his 'C' index which provided a value of MIIT that focused on matched trade shifts and only has positive values. However, his 'C' index cannot address unmatched trade flows (Menon and Dixon, 1997).

2.3. Hosein-Seecharan (HS) Index

Hosein and Seecharan (2013) further refined Brülhart's 'A' index by considering only bilateral/two-way trade flows of export and import quantities. Hosein-Seecharan built upon studies by Fontagne and Freudenberg (1997) who focused only on bilateral flows as they conferred that when this criterion is not adhered to in the GL index, it can lead to geographical and sectoral/product bias[1]. Also, the HS index applied the Intensity measure (I_i) proposed by Nilsson (1999) and Boring (2012) to better capture IIT, given that a few commodities may record high IIT levels compared to the average over all commodities in the dataset. I_i represents the number of commodities traded strictly bilaterally with the respective trading partner(s). The sum ($\sum_{i \in j}$) of good$_i$'s trade flow (where i=1,2,3…), constitutes the industry as follows:

$$A_{ij}^{HS} = HS = \frac{\sum_{i \in j}\left(1 - \frac{|\Delta X_i - \Delta M_i|}{|\Delta X_i| + |\Delta M_i|}\right)}{I_i} \quad (3)$$

The HS index's result ranges from 0 (marginal inter-industry trade) to 1 (marginal intra-industry trade).

2.4 Main concerns with Established Methodologies

When we consider the established methodologies, researchers have argued that there still exist some concerns when one is measuring IIT levels. For simplicity, Table 1 below provides a non-exhaustive account of the main concerns that arise. They are grouped under three broad headings: Product/Categorical Aggregation Bias, Trade Imbalances and Weighting/Scaling Effect, and Other Issues for both the static and dynamic indices.

However, one major concern is the question on what constitutes an industry which has been long debated. Finger (1975) argued that Grubel "explained" IIT in his proposed IIT index by implicitly defining an "industry" such that traditionally understood inter-industry trade concepts became intra-industry trade. Robert Davies (1978) in an Economic Inquiry Journal

[1] Geographical Bias occurs when countries are grouped together or when one country is compared to the world in computing the GL's IIT index which ignores the possibility that the sign of a good's trade balance (*X-M*) may differ among countries. However, sectoral/product bias occurs from categorical aggregation when more goods are grouped and classified under one industry, the greater the chance of more IIT being recorded (Fontagne and Freudenberg 1997).

stated that without a thorough analysis of the nature of specific industries, it is impossible to be sure that the observed exchange of products signifies genuine intra-industry trade. However, Davies (1978) confirmed that there are numerous cases where trade overlap arises in the three-digit (and even more in the four and five digit) SITC classification. Nonetheless, researchers such as Ferto and Soós, 2020; Greenaway and Milner, 2003; Kalbasi, 2003; Silgoner and Steiner, 2019 have come to accept that the 3-digit Standard International Trade Classification **(**SITC) is the most suitable mechanism in defining an industry.

Table 1. Main concerns with Established Methodologies.

	Product/Categorical Aggregation Bias	**Trade Imbalances and Weighting/Scaling Effect**	**Other Issues**
STATIC INDICIES	• Critiques of Grubel-Lloyd's (1975) index highlighted its categorical aggregation bias which is the classification of goods from the same industry that have dissimilar factor ratios and therefore are different, causing an overvaluation (bias) of the GL index.	• Grubel and Lloyd (1975) have been criticised for not accounting for trade imbalances in its b_j index which represents a situation where the exact weighting effect in industries is dependent on the uniformity of the signs of trade flow imbalances of each subgroup within an industry. GL adjusted this via his b_j (adj) index which calculates IIT as a share of total trade net of trade imbalance and it increases by the same proportion at all levels of aggregation. • Rajan (1996) mentioned one drawback in his R_i Index, that it takes on an estimate of infinity when no IIT exists, as one denominator is assumed to be 0. This represents in essence the scaling effect where the size of the value can skew the result if not appropriately applied.	• Nilsson's (1999) IIT index has a drawback in its ability to compare IIT results and specialisation between countries. This is especially important given that some countries are larger and trade more commodities and therefore experience higher IIT levels.
DYNAMIC INDICIES	• In terms of dynamic indices, Brülhart's (1994) 'B' index cannot be combined across industries since it would produce values closer to 0 or high IIT levels.	• Shelburne (1993) stated that no consensus was reached on how to deal with trade imbalances in existing IIT research.	• Greenaway et al. (1994) were unable to capture the changes in trading patterns as their dynamic indices measured differences in IIT over two periods.

Note: Hosein-Seecharan (2013) and authors additions (non-exhaustive).

2.5. Proposing a Revised Methodological Framework

Greenaway and Milner (1987, 44 to 45)**Error! Bookmark not defined.** highlighted two concerns related t o the measurement of IIT for which researchers have not yet reached a definite consensus: *"(i) whether and how one should adjust for aggregate payments imbalance and (ii) the identification of and adjustment for categorical aggregation".* This paper aims to propose new modifications to the measurement/calculation of IIT to add to the wealth of existing literature outlined below.

An earlier adjustment to the measurement of IIT by Grubel and Lloyd (1975) aimed to account for overall trade imbalance; this involved calculating IIT as a fraction of the total trade, after subtracting the trade imbalance. Aquino (1978) conferred but showed that their adjustment does not consider disaggregate data as it focuses on total trade. Aquino further stated that overall trade imbalances do have an imbalancing impact on single commodity trade flows which means that single trade flows may have a positive/negative balance, but it is not reflected when overall trade flows are computed. Aquino therefore proposed that the imbalancing effect can be equiproportionally distributed to all industries, on the multilateral trade flow basis. Loertscher and Wolter (1980) applied the measure by Aquino to bilateral trade imbalances of manufacturing products. Bergstrand (1982) also utilised bilateral trade flows but focused on a correcting factor for total trade imbalance and like Aquino, it is taken as equiproportionally distributed across industries. Bergstrand's correcting factor included the arithmetic mean of a country's exports and imports from (to) country i to (from) country j and both factors act in the same direction when one country (*i* or *j*) has a deficit and the other a surplus. The factors are offset when both countries have the same trade imbalance, and the iteration is completed when all countries reach a multilateral equilibrium.

Alternatively, to account for trade imbalances in the measurement, Greenaway and Milner (1981) proposed (i) to ignore the possible balancing effects at the disaggregated level to focus more on what is happening in the industry (micro-level) and not the overall adjustment (macro-level); (ii) to exclude transitory periods when there are significant payment adjustment forces in cross-sectional modelling; or (iii) to compute the average of the indices for the time periods of significant payment adjustment forces to combat Aquino's arbitrary equiproportional rule. A more recent adjustment for the problem of trade imbalance was offered by Njegovan (2021) who adapted the GL index to include a classification of non-overlapping trade flows on whether they originate from exports ($X > M$) or from imports ($M > X$) in the form of a weighted average ($\overline{B}$ index). He also considered that the GL index cannot

declare a maximum value in the presence of an imbalance and thus adjusted the denominator to subtract the absolute value of exports minus imports ($\overline{C}$ index). His alternative solution to trade imbalances was in the form of an index applying equal weights (NN). He proposed that $\overline{B} \leq \text{NN} \leq \overline{C}$, where the equality of coefficients is attained in the case of a trade balance.

On the other hand, earlier adjustments for categorical aggregation stemmed from researchers such as Greenaway and Milner (1986) who proposed two approaches; to either reclassify trade statistics or to estimate a weighted average IIT index founded on ungrouped data at SITC 5 or 6 digit. However, practical disadvantages such as the tedious nature of reclassifying trade statistics as well as the absence of a general reclassification standard lead Greenaway and Milner to the second approach. Though, Gullstrand (2002) noted that estimating a weighted average IIT index on ungrouped data at SITC 5 or 6 digit does not cancel out opposing trade-imbalance signs at a sub-industry level. For example, in Luka and Levkovych's (2004) paper, they used the 6-digit Harmonized System nomenclature and calculated the weighted average of sub-industry IIT levels for commodity groups for sole trading partners, country groups and the world across the specified time. They investigated the process of economic transformation in Ukraine and the evolving trade patterns in agricultural and food products. They found that major changes tracked in the direction of trade flows, with the IIT weight of both the EU and developing nations growing in terms of total trade. Moreover, Fontagne and Freudenberg (1997) argued that to combat aggregation bias, one needs to ensure that disaggregated data is used, and the index only includes bilateral flows to minimise geographic aggregation bias. However, Vona (1991) accounted for this issue of aggregation by using 5-digit SITC categories to represent basic industries and then re-grouping them at the 3-digit level; thus, making the index non-responsive to changes in the level of data disaggregation chosen.

Later researchers have also attempted to correct for aggregation bias such as Hayakawa et al. (2017) who found that bilateral trade in product-country pairs on a marginal basis, are very unpredictable using disaggregated data of OECD nations. In other words, they found that many commodities shift among bilateral (two-way trade), unilateral (one-way trade) and zero-trade over time. Hayakawa et al. therefore proposed an IIT Stability index with a scoring rule where the index adds one when the commodity alternates from non-IIT to IIT and then if it maintains a consecutive level of IIT, an incremental score of one is added. They noted that any incremental score can be used but for their index, the straightforward rule of raising the increment by one for each successive year of IIT was used. After this, the score of k-years of

successive IIT is then multiplied by the number of runs of *k*-years of successive IITs (X_k)[2]. Hayakawa et al. argued that their analysis at HS 6-digit level (5000 categories) is far less susceptible to aggregation bias as compared to Culem and Lundberg's (1986) computation of the correlation coefficients of GL IIT index at ISIC 4-digit (100 categories) between two years. Their results indicate that bilateral trade involving varied market sizes and far distances are likely to shift more among trade flow types. Also, primary products are more likely to switch among manufactured products.

Moreover, a more recent paper by Mukerji and Panagariya (2019) presented a new index that categorised trade as IIT purely if exports and imports are neighbouring alternatives as determined by the mean proximity of their prices. This clearly indicates that researchers are delving deeper into aspects of the definition of IIT, i.e. "trade in differentiated products which are close substitutes*"* (Grubel and Lloyd, 1975, 1), to better capture IIT levels. They examined both United States export and import figures at the HTS 10-digit product level from 1989 to 2001 by employing the amount and value linked with the trade flow to calculate the unit value which they considered the price of the specific type of good. They establish that, "the higher the price (unit value), the higher is the quality of the variation" (Mukerji and Panagariya, 2019). Using the unit values of each commodity, they get the mean and spread of each import and export flow and consequently test the null proposition that the two averages are identical (Mukerji and Panagariya, 2019). If the null is accepted, IIT is found for that commodity in that year. If the null is rejected, there is no IIT in that commodity. Their index calculated IIT based on product characteristics of quantity and unit price irrespective of the data aggregation level used and found overall lower levels of IIT recorded. This is in comparison to the GL index which increases as categorical aggregation of data increases.

Additionally, when looking at the previous methods of calculating IIT, one can infer that depending on the observation/theoretical principle in the economy being examined, the GL, BH and HS Indices, *among others*, were modified/corrected to better fit the observation/theoretical principle. This approach has both advantages and drawbacks. This paper therefore attempts to further address the above two issues of accounting for trade imbalances and categorical aggregation bias by proposing straightforward procedures outlined in the following section.

[2] To turn the score into an index, it is divided by the total score $\left(\sum_n^k n = \frac{\mathrm{k(k+1)}}{2} = 153\right)$ that can be obtained for the number of consecutive years ($where\ k = 17\ years$) which is similar to the 'Intensity' Measure of IIT.

3. Modified Methodology

In this section the proposed modified methodology is presented, and a detailed account of the proposed adjustments is provided. It is important to note that the earlier methodologies possess strengths in its intended context and so this paper does not intend to argue with its merits, but rather present an alternative empirical methodology that can lend itself to a more holistic and focused approach to capturing IIT levels for use by CARICOM and other developing nations.

3.1. Holistic Intra-Industry Trade (HIIT) Index

This modified index, that can be referred to as the Holistic Intra-Industry Trade (HIIT) Index calculates the change in exports and imports for $good_i$ in same manner as the HS Index. However, during calculation, it is modified to include both bilateral and unilateral trade flows between trading partners in calculating the sum of $good_i$:

$$A_i^H = \left(\frac{1 - \frac{|\Delta X_i - \Delta M_i|}{|\Delta X_i| + |\Delta M_i|}}{I_i} \right) \quad ; \quad 0 \leq A_i^H \leq 1 \quad and \quad \frac{|\Delta X_i - \Delta M_i|}{|\Delta X_i| + |\Delta M_i|} > 0 \qquad (4)$$

It also applies the Intensity measure of IIT and the scaling effect $\frac{|\Delta X_i - \Delta M_i|}{|\Delta X_i| + |\Delta M_i|} > 0$ which would be further discussed below. On the commodity level, the HIIT Index's result ranges from 0 (marginal inter-industry trade) to 1 (marginal intra-industry trade).

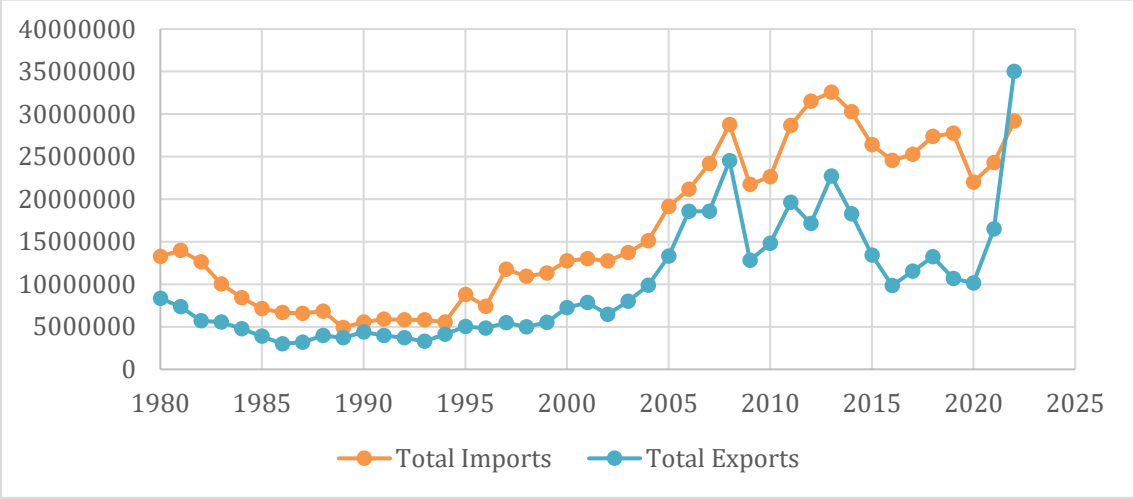
Though the Brülhart 'A' index and the HS 'A_{ij}^{HS}' index provide a solid basis for measuring IIT, researchers are still deliberating on two concerns (accounting for trade imbalances and categorical aggregation bias). The modified measurement therefore provides two post-calculation procedures which would be further discussed below.

3.1.1. Including both Bilateral and Unilateral Trade Flows

Including both bilateral and Unilateral flows were proposed to capture a more balanced understanding of trade flows, based on Balassa's 1965 notion. Balassa explained that "more could be gained if, instead of applying general principles to attempt to explain actual trade flows, one can use the observed pattern of trade as a point of departure and then try to find the main influences that have determined the pattern via further research" (Balassa 1965, 116 - 117). CARICOM countries' trade flows to the World exhibit higher import values in comparison to exports in overall trade as depicted below in Figure 1 which has been a well-known occurrence due to market forces of globalisation and competition, among other things.

This can be further depicted on the commodity level[3] , see Figure 2[4], where imports are in the majority and thus the red arrows highlight the strong presence of this one-way (unilateral) trade flow. As such, excluding unilateral trade flows reduce the ability of the HS index to capture a key feature of CARICOM trade, for which this modified index attempts to resolve. This modified index can also be applied to similar small island developing states (SIDS).

Figure 1. Total CARICOM imports and exports to the world, 1980 to 2022.

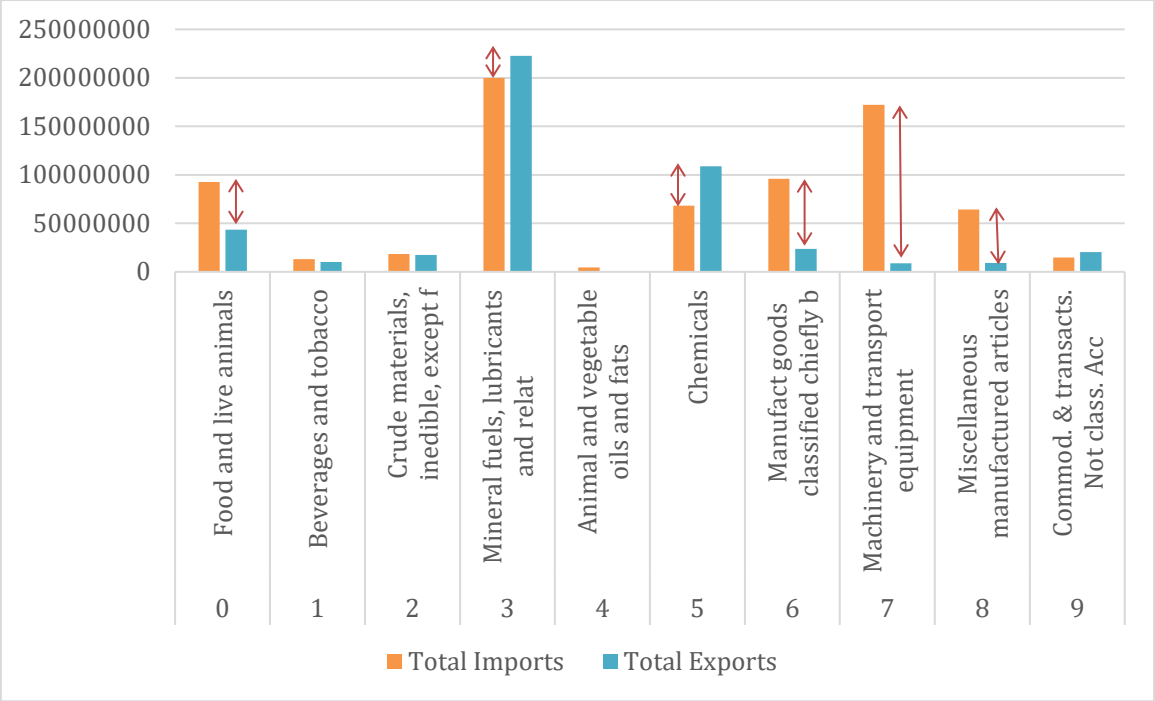


Note: *x* axis showing total exports and imports, y axis showing total trade value in USD$.

[3] 1-digit Product Grouping via SITC Revision 1 dataset from WITS.

[4]The main product group driver giving rise to the point in 2022 where CARICOM's exports are higher than imports to the world for 2022 is outlined in Figure A1 at the Appendix.

Figure 2. CARICOM imports and exports to the world on the commodity level (1-Digit) for 2022.



Note: *x* axis showing total exports and imports by sector, y axis showing total trade value in USD$.

Moreover, the notion to include both bilateral and unilateral flows are based on the existing patterns in trade flow data. For example, a country's unilateral trade flow recorded exports alone for the year 2005 for $good_i$ at the 3-digit level. That same $good_i$ also recorded a level of exports and imports (bilateral trade flow) in the year 2007. This means that a country can have both bilateral and unilateral trade flows over time for $good_i$. Including both flows would help to better measure marginal IIT as the measurement does not focus on the direction of the trade flow, but rather the presence of trade flows in relation to each other. This procedure also allows for better comparison with other countries who may have higher levels of inter-industry trade that is not reflected in the HS index. Many researchers argued that including both bilateral and unilateral trade flows are a flaw to measuring IIT (Fontagne and Freudenberg, 1997; Loertscher and Wolter, 1980; Bergstrand, 1982 and Hosein-Seecharan, 2013). Fontagne and Freudenberg (1997) contended that it could lead to geographical and sectoral/product bias. However, this paper aims to build upon this notion to demonstrate, inter alia, that including unilateral flows provide great explanatory power for the level of IIT existing between partners, especially CARICOM markets.

Moreover, Dutta (2022) stated that in both approaches to measuring IIT (trade recovery and type of trade approach), unilateral/one-way trade flows were included, dependent on the definition of inter-industry trade used. Grubel and Lloyd (1975) and Brülhart (1994) followed

the trade recovery approach which defined IIT as bilateral flows that perfectly overlapped within an industry whereas inter-industry trade was the remaining flows that did not overlap (unilateral/one-way trade). Moreover, Abd-el Rahman (1986) and Vona (1991) followed the type of trade approach which stated that intra-industry trade exists when the ratio of the smaller flow to the majority is not too minute for total trade registered in each industry; otherwise, inter-industry trade exists. Researchers such as Aquino (1978), Brülhart (1994) and Balassa (1986) also included unilateral trade flows in their measurement of IIT, which provides a foundation for our modified index.

The notion of including unilateral flows is also supported by the findings of Hayakawa et al. (2017) who detail that bilateral trade in product-country pairs, on a marginal basis, are very unstable via disaggregated data of OECD countries. In other words, they found that many products 'shift' among bilateral (two-way trade), unilateral (one-way trade) and zero-trade across time. To counteract this, Hayakawa et al. proposed an 'IIT Stability index' and their results indicated that bilateral trade concerning markets of varied market sizes and far distances are prone to be unstable (i.e. shifting from bilateral to unilateral to zero trade flows) and that primary commodities are more unstable than manufactured commodities. Hence, in our modified measurement, we aim to include both bilateral and unilateral trade flows to capture the shifting trade pattern on the commodity level, as it was proven to be a significant feature of CARICOM data.

3.1.2. Intensity Measure of IIT

Our modified index applies an intensity measure, represented by I_i, similar to the Hosein-Seecharan (HS) index. The intensity measure is calculated as MIIT divided by the total amount of commodities traded between trading partners on the industry level. It is based on the works of Boring, 2012 and Nilsson 1997, 1999.

Specifically, the modified index remains consistent with Boring's (2012) explanation where a country may have two-way trade in a few products, thus recording higher or more concentrated levels of IIT while the standard average GL index may be low across all commodities. As such, applying the intensity measure of IIT helps to get a better understanding of IIT levels in relation to total trade. For the modified index, Boring's measure of intensity for bilateral flows are extended to unilateral flows.

The modification also builds upon Nilsson (1997) explanation that the GL index was unable to precisely capture the level of IIT with the existence of trade imbalances partially due

to evaluating IIT between countries with large variations in economic size. Nilsson (1999) therefore proposed an improvement where the bilateral level of IIT is divided by the total amount of commodities exchanged between two nations to yield a mean level of IIT per commodity.

3.1.3. Scaling effect

Rajan (1996) mentioned one drawback in his R_i Index, that it takes on an estimate of infinity when no IIT exists, as one denominator is assumed to be 0. This represents in essence the scaling effect where the size of the value can skew the result if not appropriately applied.

The condition introduced where $\frac{|\Delta X_i - \Delta M_i|}{|\Delta X_i| + |\Delta M_i|} > 0$ accounts for issues where no trade flow occurs but IIT is found, thus reducing the issue of the scaling effect. In calculating the IIT index, sometimes a situation arises where no trade occurs, but IIT is still recorded. Therefore, the above condition is applied through the HIIT Index to account for this shortfall. This effect is illustrated in Table 3 below.

3.1.4. Proposed Procedure to Address Trade Imbalance Issue

Trade imbalances concern a situation where a product subgroup may have overall more exports than imports, or vice versa, causing an imbalance in trade flows. The exact weighting effect within industries is therefore dependent on the uniformity of the signs of trade imbalances of each subgroup within an industry.

Moreover, Vona (1991, 687) states that: "*the claim in the "need for correction argument" that correction is necessary at the most elementary level of disaggregation is even more unconvincing, at least in Aquino's version. There is absolutely no justification for this on either theoretical or empirical grounds. For example, it is really hard to imagine why France's foreign trade with Italy in "machinery for manufacturing or finishing of felt" (SITC1 group 717.14) or "electric shavers and hair clippers" (SITC1 725.04) should be balanced, and moreover, how imbalances in these product groups could eventually give rise to macroeconomic reactions leading to equilibrium*".

Accordingly, the modified HIIT Index builds upon Njegovan's (2021) paper, which adapts the GL index to include a classification of non-overlapping trade flows on whether they originate from exports ($X > M$) or from imports ($M > X$) in the form of a weighted average ($\overline{B}$ index).

In line with Njegovan and supported by Vona, our index does not focus on removing or reducing trade imbalances, but rather on separating the trade imbalance on two conditions to improve the analysis and interpretation of IIT levels. Within an industry, a simple procedure is proposed to separate good i's trade imbalances (where i=1,2,3…) on two conditions:

(i) if the sum of good *i*'s exports[5] < imports (net importer) and

(ii) if the sum of good *i*'s exports > imports (net exporter).

IIT is then found at a common threshold of > 0.5 by invoking the use of the established GL index.

This procedure can be extended to locate commodities within a specific industry that has recorded IIT levels between 0.4 and 0.5 as this range presents potential commodities for which policymakers can examine to improve the levels of IIT recorded (i.e increase bilateral and/or unilateral trade levels). This procedure shares a similar intention to the International Trade Centre's (ITC) Export Potential Indicator (EPI).

Noting that the BH, HS and HIIT indices look at the marginal change in IIT and cannot be aggregated across industries, the GL index is invoked as it provides a basis of comparison of commodities within an industry. This procedure can also be conducted on the industry level to compare the net exporter (net importer position) of various industries.

This procedure is considerate of Fontagne and Freudenberg's (1997) notion that including anything other than bilateral flows would result in geographical bias as it ignores the possibility that the sign of a good's trade balance (*X-M*) may fluctuate among the countries, when countries are grouped together or when one country is compared to the world to measure IIT. Hence, this procedure separates the sign of a good's trade imbalance (*X-M*) on two conditions, (when $X<M$ and $X>M$), for a reporter country's trade with its partner country. This provides a better evaluation and interpretation of IIT findings and corrects for the major issue with trade imbalances. Additionally, when there is an identical change in *X* and *M*, this procedure helps to distinguish whether there was a contractionary or expansionary pressure. Thus, correcting for the deficiencies of Menon and Dixon's (1997) index.

[5] The sum of good i's exports is used to represent the industry i as it may be more useful to calculate trade imbalances on the industry level. The standard GL index is used to calculate on the industry level when X < M but the absolute value is removed when $X > M$.

3.1.5 Proposed Procedure to Address Categorical Aggregation Bias

Many researchers have tried to account for issues with categorical aggregation by, for example, measuring IIT at the 4-digit or 5-digit SITC disaggregated level instead of the 3-digit level to represent the industry. Vona (1991) accounted for the issue of aggregation by using 5-digit SITC categories to represent basic industries and then re-grouping them at the 3-digit level, thus making the index non-responsive to changes in the level of data disaggregation.

Greenaway and Milner (1987) proposed that there are two approaches to deal with the aggregation issue; to recategorize trade statistics or to calculate a weighted average IIT index based on ungrouped data at SITC 5 or 6 digit. Practical disadvantages such as the tedious nature of reclassifying trade statistics as well as the absence of a general reclassification standard lead Greenaway and Milner to the second approach. However, Gullstrand (2002) noted that estimating a weighted average IIT index on ungrouped data at SITC 5 or 6 digit does not offset opposing trade-imbalance signs at a sub-industry level. Another limitation of Greenaway and Milner's index is that it is downward prejudiced if the trade imbalances of the two variations have opposing signs.

Moreover, Hansson presented a solution to address discussions on whether IIT was only a wonder of aggregation (that is, whether it solely relies on the way trade statistics are ordered and collated). Hansson (1989) proposed that one should study how the selection of the level aggregation influences the share of IIT by computing IIT on different levels of aggregation. Using SNI six-digit data, the below formula is proposed where a is the aggregation level representing the industries and n_a is the amount of industries on that aggregation level.

$$\mathrm{IIT}_{aj} = 1 - \frac{\sum_{i=1}^{n_a} |\mathrm{X_{ij}} - \mathrm{M_{ij}}|}{\sum_{i=1}^{n_a} (\mathrm{X_{ij}} + \mathrm{M_{ij}})} \tag{5}$$

Take for instance if IIT_{aj} is calculated on a higher level of aggregation than IIT_{bj}, as demonstrated in Eq. 6 below, $\mathrm{IIT_{aj}}$ is always $\geq \mathrm{IIT_{bj}}$. This is because the absolute value of net trade of industries on the higher aggregation level $|NT_{aj}|$ is less than or equivalent to the sum of the absolute values of net trade of industries on the lower aggregation level $|\mathrm{NT_{bj}}|$.

$$\left|\mathrm{NT}_{aj}\right| = \left|\sum_{h=1}^{n_b} \mathrm{X_{hij}} - \sum_{h=1}^{n_b} \mathrm{M_{hij}}\right| \leq \sum_{h=1}^{n_b} |\mathrm{X_{hij}} - \mathrm{M_{hij}}| = \left|\mathrm{NT}_{bj}\right| \tag{6}$$

Industries on the lower level of aggregation (b) are denoted by h. h is likewise included in subgroups of I, which means h is also included in the group of industries being compared at the higher level of aggregation (a) above. If net trade in the two directions arises on the smaller aggregation level, IIT_{aj} is greater than IIT_{bj}. Net trade with different signs on the smaller

aggregation level negate the value on the larger aggregation level. Additionally, if country *j*'s trade is distorted/unbalanced (exports ≠ imports), IIT_j is always < 1.

Many various forms of adjustments have been proposed to "correct" for the impact that distorted trade has on Grubel-Lloyd's index. However, in Hansson's explanatory and mathematical studies, he utilized only unadapted measures. Since equilibrium can exist despite distorted trade, one can inquire whether the "correct value" of Grubel-Lloyd's index is the actual value when trade balances for the country.

Upon examination of IIT levels in Swedish foreign trade, Hansson found that the size of IIT declines, as the disaggregation of data increases. Therefore, IIT may be a query of aggregation, given that a suitably utilized disaggregation will result in the disappearance of virtually all IIT, for example, if each industrial facility equates to an industry. However, Eq.6 is an arithmetic property of Grubel-Lloyd's index and has little to do with the sources of IIT. Eq.6 does not indicate that any disaggregation will reduce IIT to null. It does not indicate that disaggregation corresponding to supply side conditions would reduce IIT. The results of Hansson's study specifies that IIT will not automatically be eliminated even if one disaggregates the data so that all companies in the industry have matching production functions. Hence, the query Hansson aimed to address in Chapter 1 of his 1989 paper remains, on the reason for the large amount of trade that may not be able to be justified by comparative advantage. Furthermore, Hansson found that over 60 percent of Swedish foreign total trade on the lowest SNI level is IIT. This therefore shows that the interchange of similar products (or IIT) is significant. Also, the portion of IIT was found to increase on all levels of aggregation between 1970 and 1983 excluding on the 0 and 1-digit levels for Sweden.

Given the above findings, we employ a similar approach to Hansson that aims to investigate the presence and impact that categorical aggregation bias has on IIT levels. Additionally, given that Fontagne and Freudenberg (1997) argued that including any other flow than bilateral flows can result in sectoral/product bias, the extent to whether categorical aggregation has any impact on the level of IIT would be explored in this paper.

Hence, to contest whether the issue of categorical aggregation bias is evident, a procedure is offered which entails comparing the modified index (A_i^H index simply referred to as the H Index) on two types of aggregation (high level SITC 3-digit and low level SITC 5-digit) as follows:

$$\text{At high level aggregation: } H_i^{HL} = \left(\frac{1 - \frac{|\Delta X_i - \Delta M_i|}{|\Delta X_i| + |\Delta M_i|}}{I_i} \right); \text{ and} \tag{7}$$

$$\text{At low level aggregation: } H_i^{LL} = \left(\frac{1-\frac{|\Delta X_i - \Delta M_i|}{|\Delta X_i|+|\Delta M_i|}}{I_i}\right). \quad (8)$$

If the value of $H_i^{HL} = H_i^{LL}$, then there is little to no aggregation bias present so its impact on IIT is negligible. In other words, the level of aggregation chosen has no impact on the level of IIT found. This is especially important as many researchers have not reached a definite consensus on what level of aggregation constitutes an industry. Hence, if $H_i^{HL} = H_i^{LL}$, one would be more confident that the level of aggregation places no bias on the level of IIT calculated. One would then choose the level of aggregation (SITC 3,4,5 or 6-digit) specific to their study.

If the value of $H_i^{HL} \neq H_i^{LL}$, then aggregation has some impact on IIT and that difference should be subtracted from the HIIT Index. To expand further, given that Hansson stated that IIT computed on a higher level of aggregation (H_i^{HL}) would always be higher than IIT on the lower level of aggregation (H_i^{LL}), due to the absolute vales of net trade at a higher aggregation level being equal to or less than net trade at lower aggregation level. In other words, the situation where $H_i^{HL} \geq H_i^{LL}$, is taken as given and is not as significant in terms of bias.

However, if the researcher finds a result wherein $H_i^{HL} < H_i^{LL}$, this will then indicate that the level of categorical aggregation has serious implications for the level of IIT found. This is because of the simple fact that each trade flow of export and imports at the disaggregated level cannot constitute an industry in and of itself. In other words, each plant cannot equal an industry in any one country. Hence this paper proposes that the situation where $H_i^{HL} < H_i^{LL}$ results in significant levels of categorical aggregation bias.

In this case, a high-level aggregation at SITC 3 digit (H_i^{HL}) is compared to a low-level aggregation at SITC 5 digit (H_i^{LL}). The same procedure is also computed for the HS index and BH index (see result Figures 6 and 7 below[6]).

4. How does this modification improve the measurement?

This modification improves the measurement of IIT as it includes both bilateral and unilateral trade flows to offer a more balanced examination of trade flows. It further captures the level of Intensity (I_i) that exists when measuring IIT. Moreover, the scaling effect introduced where $\frac{|\Delta X_i - \Delta M_i|}{|\Delta X_i|+|\Delta M_i|} > 0$ is intended to bring about an improvement in the calculation of IIT by accounting for issues with mathematical classifications, thus reducing the issue of capturing

[6] The HIIT Index is constructed with WITS' existing trade flows as follows: one 3-digit product code (013) from 2010 to 2022 and three 5-digit product codes (01181, 01189, 03201, 03202) from 2010 to 2022.

IIT when no IIT exists. The modification also considers trade imbalances on the industry level, through a procedure to separate two conditions (where $X<M$ and $X>M$) among the varying industries. Also, the HIIT Index quantifies whether the level of aggregation has any impact on the amount of IIT that exists (aggregation bias) by using a comparison on two levels of aggregation.

Notably, the observed pattern of trade can guide the choice of IIT index. Therefore, future research can be carried out to classify the observations/theoretical principles applied, upon some common inference, to ascertain the most accurate reflection of IIT for a particular country/industry case (as with the combined use of the HIIT Index and GL in this study at the commodity and industry levels, respectively). There is room for a future framework to guide researchers on which index may be best suited via generalised scenarios.

For ease of comparison, Table 2 below provides an overview of the differences with Established Indices vs. Modified Index which were discussed in detail earlier in section 2 and 3.

Table 2. Recap of the Differences with Established Indices vs. Modified Index.

BH Index	**HS Index**	**HIIT Index**
Measures IIT for all trade flows of $good_i$ i.e bilateral, unilateral and zero trade flows.	Measures IIT for $good_i$ that records strictly bilateral/two-way trade flows.	Measures IIT for $good_i$ that records both bilateral and unilateral trade flows for a more balanced examination of trade flows.
Cannot be aggregated across industries as it would result in a value closer to 0.	Prevents overvaluation/undervaluation of MIIT.	Prevents the scaling issue where no trade flow occurs but IIT is found.
Does not account for product biases and accepts SITC 3-digit to represent an industry.	Minimises product biases by removing unilateral trade flows.	Investigates whether there exists categorical aggregation bias and its impact on IIT.
It does not distinguish whether higher IIT values are recorded in only some commodity groups and therefore has no measure of intensity.	It introduces I_i (total amount of commodities traded strictly bilaterally between trading partners) which measures MIIT intensity. However, the HS index can be applied independently of I_i.	It focuses on improving the balance of trade flows rather than improving trade flow in respect to total number of commodities, by introducing a simple procedure to separate the imbalance when X<M and X>M at the total commodity level. This result can be extended to include potential IIT improvements when 0.4 < IIT < 0.5. However, the intensity measure (I_i) remains consistent with the HS index.

5. Results of Modified Index

In this section we provide the results of the proposed modification for calculating IIT via the use of a sample scenario in table 3 below. This section also addresses the concerns with the established methodologies identified in section 2, table 1 via an examination of CARICOM's IIT levels.

When looking at Table 3 below, one can conduct analyses to witness how IIT levels vary with changes to the methodology/assumptions. For the year 2017 no trade flow is recorded, however results for both the GL and BH index states that Inter-IT exists. Both the GL and BH indices treat the absence of trade as "perfect intra-industry trade." However, this can be misleading since no trade is occurring. As such, the HIIT Index corrects for this by applying the condition where $\frac{|\Delta X_i - \Delta M_i|}{|\Delta X_i| + |\Delta M_i|}$ must be > 0 in order to account for issues where no trade flow occurs but IIT is found. The Scaling Condition ensures that only goods with a non-zero trade flow (changes in exports or imports) are considered.

Moreover, the HS index does not capture unilateral flows (as in 2018 and 2019) which can prove to have great explanatory power for the level of IIT, as in the case of CARICOM. As such, the HIIT Index is modified to include unilateral flows.

The sum of product *i*'s exports and imports is assumed to represent the total industry i in this sample scenario. The standard GL index is used to calculate on the industry level and in this case $X > M$ and so the absolute value is removed. The BH, HS and HIIT Index are dynamic in nature and therefore not applicable to measure the level of IIT across industries and so the GL static index is used. In this paper, the researcher uses a combination of the HIIT Index to explain trade flows on the commodity level and the GL index on the industry level.

In terms of accounting for trade imbalances, the proposed procedure to separate trade flows on two conditions ($X>M$ and $X<M$) for commodities within an industry can be illustrated in table 3 below, the sample scenario. For product *i*, $X>M$ as 35>20 and so the level of IIT found was 0.73. Policymakers can then compare this result to other commodities within the same industry to decide how to improve the levels of IIT recorded (i.e., either increase/decrease bilateral or unilateral trade levels).

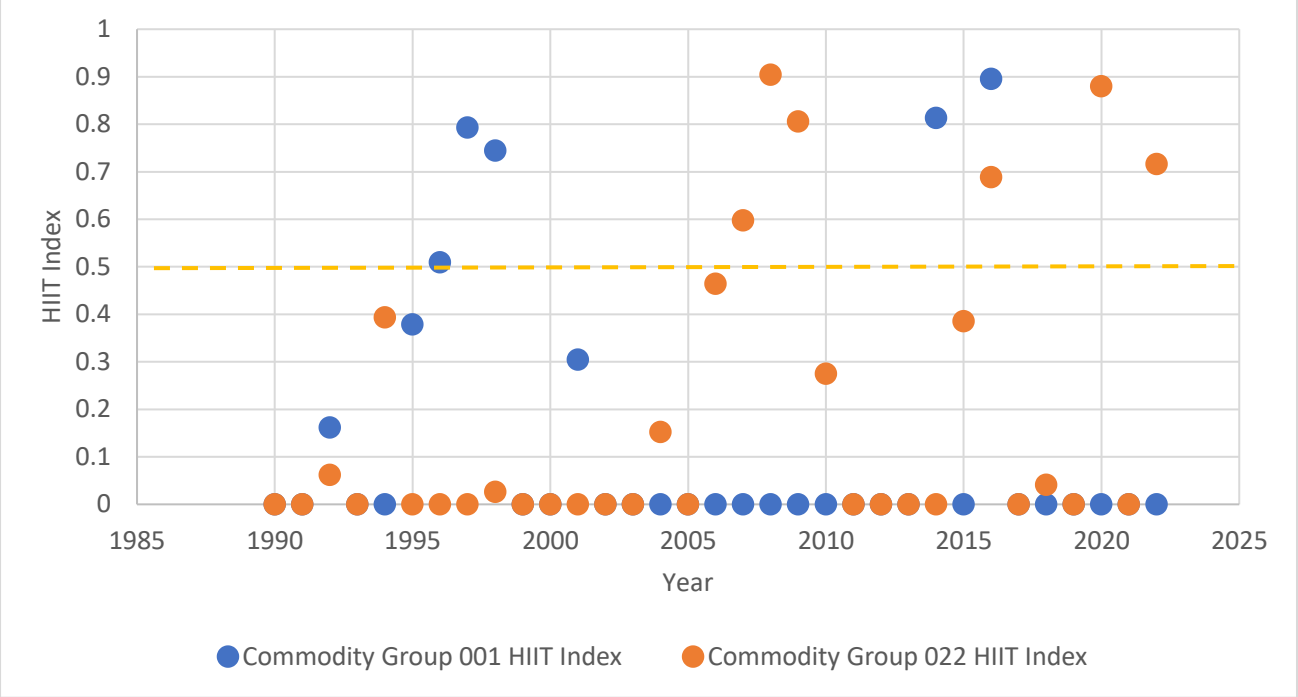
Table 3. Established Indices vs. Modified Index - Accounting for Trade Imbalances and Scaling effect via Sample Scenario.

Trinidad and Tobago to Guyana				$1-\frac{\lvert X_i - M_i\rvert}{X_i + M_i}$		$1-\frac{\lvert \Delta X - \Delta M\rvert}{\lvert \Delta X\rvert + \lvert \Delta M\rvert}$		$\frac{\sum_{i\in j}\left(1-\frac{\lvert \Delta X_i - \Delta M_i\rvert}{\lvert \Delta X_i\rvert + \lvert \Delta M_i\rvert}\right)}{I_i}$		$\left(\frac{1-\frac{\lvert \Delta X_i - \Delta M_i\rvert}{\lvert \Delta X_i\rvert + \lvert \Delta M_i\rvert}}{I_i}\right)$	
			Established Indices							**Modified Index**	
Product *i*	***X***	***M***	**Intuitively**	**GL Index**	**Result**	**BH Index**	**Result**	**HS Index**	**Result**	**HIIT Index**	**Result**
2015	10	5	IIT	0.67	IIT	0.67	IIT	0.66667	Marginal inter IT	0.67	IIT
2016	5	10	IIT	0.67	IIT	1	IIT	1	Marginal inter IT	1	IIT
2017*	**0**	**0**	**None**	**1**	**IIT**	**1**	**IIT**	**-**	**-**	**0**	**None**
2018	20	0	Inter IT	0	Inter IT	0	Inter IT	-	-	0	Inter IT
2019	0	5	Inter IT	0	Inter IT	0.4	Inter IT	-	-	0.4	Inter IT
Total Industry *i***	*35*	*20*	Some level of IIT but cannot tell exact value	*0.73*	*IIT*						

5.1. On the issue of Analysis at the Industry Versus Commodity level

In this section, it is aimed to shed light on the need to distinguish between industry and commodity level when measuring IIT as both can give very different results.

Figure 3. CARICOM'S IIT with Trinidad and Tobago at the Commodity level, 1990 to 2022.



Note: *x* axis showing commodity group 001 and 002 over the period 1990 to 2022, y axis showing the level of IIT that exists using the HIIT Index. For the years 1990 to 1995, 1999 to 2013 and 2017 to 2022 – IIT was mostly recorded at 0 and < 0.4. For the years 1990 to 2006, 2010 to 2015, 2017 to 2019 and 2021 – IIT was mostly recorded at 0 and < 0.46.

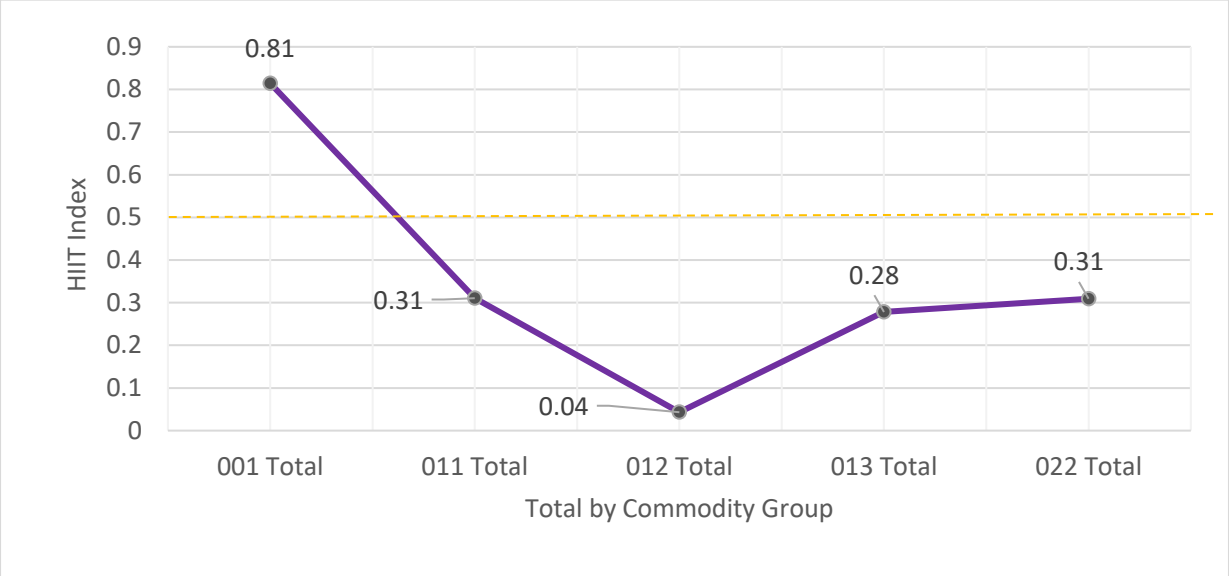
Specifically, when looking at Figure 3, one can notice that the occurrences of IIT levels (values greater than 0.5) between CARICOM and Trinidad and Tobago are lower for commodity group 001 over all three indices as compared to commodity group 022 which records both higher levels of IIT and more occurrences of IIT over all three indices. One may infer therefore that overall, there is a greater level of IIT in commodity group 022 over the period 1990 to 2022.

However, when looking at CARICOM's IIT with Trinidad and Tobago on the Industry level[7] via Figure 4 below, one can clearly see that commodity group 001 has a higher level of IIT in comparison to what was previously inferred. These results therefore demonstrate the

[7] As specified earlier, the GL Index is used to calculate IIT on the Industry Level. Additionally, for computation purposes the industry comprised of SITC 3-digit trade flows from the first 5 product codes (001, 011, 012, 013, 022) and the previously discussed trade flow conditions were applied for the indices. Data in Tables 4 and 5 sourced from World Integrated Trade Solutions (WITS).

crucial need to consider IIT levels on both the commodity and industry levels to understand the country's trade flows with its partners.

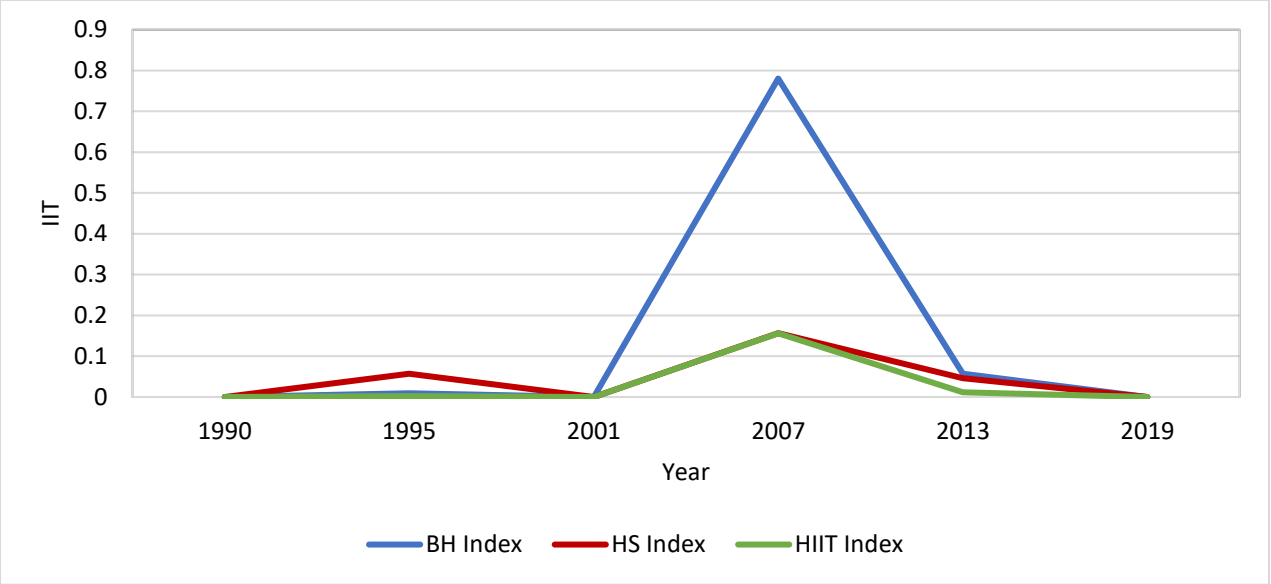
Figure 4. CARICOM'S IIT with Trinidad and Tobago at the Industry level, 1990 to 2022.



Note: *x* axis showing Total IIT by commodity group over the period 1990 to 2022, y axis showing the level of IIT that exists using the HIIT Index

We now turn to an illustration of the differences between the established IIT indices and the modified index. In Figure 5 one can see that the BH index is quite overvalued for the year 2007 which was a major concern, highlighted in the earlier section, by critiques of the BH index. Therefore, to mitigate the issues arising from the overvaluation of IIT, the modified HIIT Index provides a more balanced approach to calculating IIT. One should also consider that the HS and HIIT indices are similar due to their consistent intensity component. However, there exists a more balanced consideration for bilateral and unilateral trade flows in the HIIT Index that the HS index does not cover. This allows a better understanding of CARICOM's established trade patterns and provide a basis for further research into the industries which capture a larger IIT level in the market.

Figure 5. CARICOM'S IIT with Trinidad and Tobago at the Industry level, 1990 to 2022 (ALL INDICES).

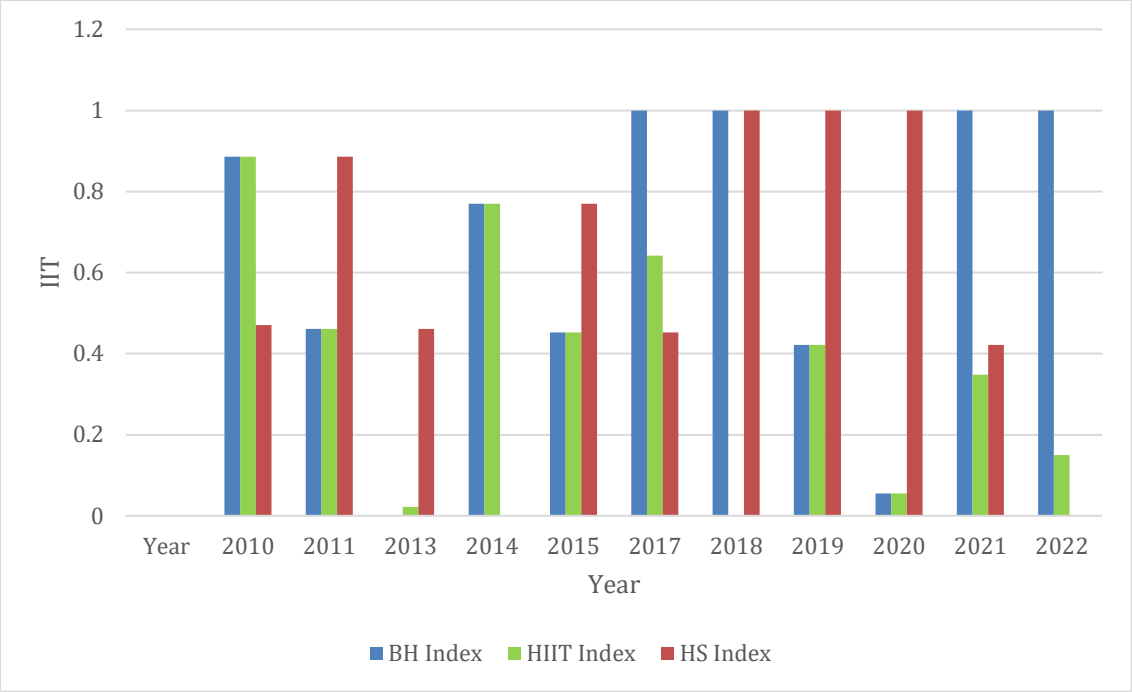


Note: *x* axis showing total level of IIT over 6-year intervals, y axis showing the level of IIT that exists.

Moreover, the proposed procedure to investigate the level of categorical aggregation bias that exists by comparing IIT on two levels of aggregation was carried out via the modified HIIT Index for trade between CARICOM and its partner, Trinidad and Tobago. In this procedure, a high-level aggregation at SITC 3 digit (H_i^{HL}) is compared to a low-level aggregation at SITC 5 digit (H_i^{LL})). If the value of $H_i^{HL} = H_i^{LL}$ there is no aggregation bias present so it's impact on IIT is zero. If the value of $H_i^{HL} < Hi^{LL}$, then aggregation a significant impact on IIT and that difference should be subtracted from the HIIT Index. The same procedure is also done for the established BH index and HS Indices to show the variations in the measurement of IIT.

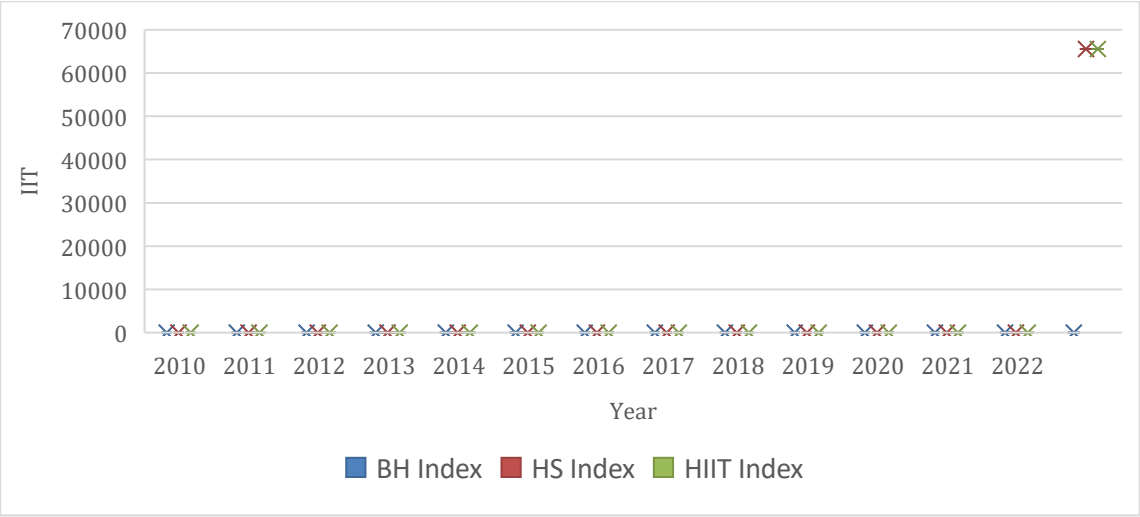
For CARICOM's intra-industry trade levels with Trinidad and Tobago presented in Figures 6 and 7 above, the SITC computation results indicate that $Hi^{HL} > Hi^{LL}$ over all the years. In other words, the difference in the IIT levels from the high-level aggregation to the low-level aggregation is an expected finding of phenomenon of IIT. Therefore, categorical aggregation could have been said to have little impact on the measurement of IIT for the sample commodity and industry examined. However, if the results were $Hi^{HL} < Hi^{LL}$, then this would have prompted serious analysis and intervention as it would be a quite unexpected finding and a clear indication that the industry is not properly defined.

Figure 6. High Level Aggregation (3 digit) and its impact on Marginal Intra-Industry Trade (MIIT).



Note: *x* axis showing IIT over the period 2010 to 2022, y axis showing IIT level.

Figure 7. Low level Aggregation (5 digit) and its impact on Marginal Intra-Industry Trade (MIIT).



Note: *x* axis showing IIT over 2010 to 2022, y axis showing level of IIT.

6. Conclusion

The theory of IIT has gained growing importance as researchers work to improve a country's international trade standing. From the early works of Béla Balassa, Herbert G. Grubel, Peter John Lloyd and many others, it has been established that IIT as it reflects a real-world phenomenon, rather than based in pure theoretical design. Grubel-Lloyd's IIT index captured

the degree to whether the export quantity matched the import quantity for a given good$_i$ (trade overlap) at one point in time in terms of total trade. Whereas Brülhart's remarkable A index measured changes between export and import quantities over time. The established Hosein-Seecharan IIT index further refined Brülhart's A index by considering only bilateral/two-way trade flows. Many adjustments in the measurement indices have been discussed which signifies that ascertaining the true value of a country's IIT is an important building block for IIT Theory, for which economists are advancing.

In this paper, we presented a modified methodology, the Holistic Intra-Industry Trade (HIIT) index, to capture the level of IIT. Results of the HIIT Index show that for CARICOM's IIT levels, there was a significant amount of unilateral trade flows (see Figure 1 and 2) and so the inclusion of unilateral flows offered a more balanced examination of trade flows and a tailored index for CARICOM markets. Moreover, the results also support the notion that careful attention should be attributed to whether the analysis is being conducted on the commodity or industry level (see figure 3 and 4, respectively). Also, the HIIT Index further captured the level of Intensity (I_i) that exist when measuring IIT, building upon the works of Nilsson (1999), Boring (2012) and Hosein-Seecharan (2013). Results show that including an intensity measure reduced the occurrence of overvaluation of the IIT index as with Brülhart's A index (see Figure 5).

Moreover, our simple condition where $\frac{|\Delta X_i - \Delta M_i|}{|\Delta X_i| + |\Delta M_i|} > 0$ was intended to bring about an improvement in the calculation of IIT by accounting for issues with mathematical classifications, thus reducing the scaling effect issue of trade imbalances. Results show that by applying the condition, it corrected for the issue where no trade flow occurred, but IIT was found (see table 3). The HIIT Index also considered trade imbalances on the industry level, through a procedure to separate two conditions among the varying industries (where $X<M$ and $X>M$) to improve the analysis and interpretation of IIT levels. The modified methodology therefore provides a solid basis to guide CARCIOM's policymakers in respect to IIT.

Also, the HIIT Index quantified whether the level of aggregation had any impact on the amount of IIT that existed by using a comparison on two levels of aggregation as demonstrated by Hansson (1989). Results show that categorical aggregation had little impact on the measurement of IIT for the sample commodity and industry examined as IIT at the high level of aggregation was greater than IIT at low level aggregation (HiHL > HiLL) over all the years (see Figures 6 and 7). If the opposite were true (HiHL < HiLL), then this would have prompted

serious analysis and intervention as it would be a quite unexpected finding and a clear indication that the industry was not properly defined.

6.1. Policy implications

The above results reiterate the growing importance of capturing the phenomena of IIT to better understand its policy implications on CARICOM's trade with other members. As the Caribbean Community (CARICOM) continues their legacy built on mutually beneficial trading relationships for its member states against the world, capturing the level of IIT that exists is the first step to pinpoint industries/commodities of potential growth (more IIT) and industries/commodities of potential retreat (less IIT), based on the country's available resources. In this regard, this paper aimed to capture IIT in scenarios where it has not been captured before by the inclusion of unilateral flows. Unilateral flows were found to be a key feature of CARICOM's trade given that CARICOM countries' trade flows to the World exhibited higher import values in comparison to export values (Figure 1) and on the commodity level unilateral flows were also significant (Figure 2). As such, the HIIT index was tailored to suit CARICOM's market to provide a tool for policymakers in the CARICOM region to better manage resources involved in IIT. The HIIT Index can also be applied to other small island developing states (SIDS).

This paper also provided practical procedures to combat issues of trade imbalance and categorical aggregation bias, founded on past IIT literature. By separating a country's IIT found on the two trade imbalance conditions, when $X>M$ ($X<M$), the country can be classified as a net exporter (net importer) in a specific commodity/industry and thus policymakers can take corrective action, if necessary, to increase/decrease IIT. Recall that IIT refers to the import and export of goods that are close substitutes/in the same industry. So, for those CARICOM countries with persistent fiscal deficits, investigating whether a net importing IIT position for a particular industry is truly beneficial in comparison to another industry, would be the starting point to better manage scare resources such as foreign exchange earnings.

Moreover, this paper explored the generally accepted definition of an industry (the SITC 3-digit classification) by investigating the categorical aggregation bias present on two levels of aggregation. Results show that categorical aggregation had little impact on the measurement of IIT as the $HiHL > HiLL$ which was an expected outcome (Figures 6 and 7

refer). In this context, policymakers are assured that the industry definition utilized in calculating IIT does not introduce any unexplained bias. By extension, this finding therefore encourages policymakers to plan initiatives to deepen the levels of IIT found, guided by industry specific research. For example, the Trinidad and Tobago Manufacturing Association (TTMA) has recently launched a strategic framework with the objective of doubling select Non-energy Manufacturing Exports by 2025 (MTI, 2021). Further analysis into the levels of IIT that exist in the non-energy manufacturing sector can be conducted to introduce initiatives targeted to deepen export flows/ reduce import flows in specific commodities. The above therefore presents a non-exhaustive account of practical policy implications for the modified calculation of IIT and its applications.

6.2. Limitations and Directions for Future Research

This paper notes that while there exist many measurements of IIT, both static and dynamic in nature, one may become overwhelmed at finding the best measure to suit their country/countries of study. Having varied stances on what is accepted as the best measure of IIT, as discussed in section 2, poses sizable limitations to a non-economic researcher in the field of IIT, who simply aims to report the level of IIT for their country/countries of study. In this regard, this paper aimed to provide a solid foundation to resolve this, by providing evidence that the observed pattern of trade be used to guide the choice among which established IIT index is used. Therefore, future research can be carried out to classify the observations/theoretical principles applied, upon some common inference, in order to ascertain the most accurate reflection of IIT for a particular country/industry case (as with the combined use of the HIIT Index and GL in this study at the commodity and industry levels, respectively). There is room for a future framework to guide researchers on which index may be best suited via generalised scenarios.

As the phenomena of IIT continues to gain significance, there is also room for researchers to continue to improve its measurement and applicability. Future assessments of specific sectors and commodities with high levels of IIT would guide policy decisions to attain the most mutually beneficial international trade arrangements for trading partners. With regards to CARICOM's market, IIT was found to be significant at the commodity level as most CARICOM countries competed on similar characteristics. Therefore, future research to understand the established lines (i.e. economic sectors and sub-sectors) of IIT and how best to improve it (whether to increase/decrease imports/exports), would be beneficial for

CARICOM's trade. The results show that the modified measurement better captures IIT levels in the context of CARICOM and can be applied to IIT analysis of other small island developing states (SIDS). Moreover, the modified calculation of IIT presented in this paper can be applied to the practical policy implications described in the previous section since the constraints of the past established methodologies are eased. Furthermore, to better investigate CARICOM's IIT, our research progresses into the power of econometric analysis to breakdown CARICOM's IIT levels on a sector-specific basis.

References

Anderson, K. (2016). "Intra-industry trade in a rapidly globalizing industry: The case of wine." *Review of International Economics* 24 (4), pp. 820-836. *10.1111/roie.12239*

Aquino, A. (1978) "Intra-Industry Trade and Intra-Industry Specialisation as Concurrent Sources of International Trade in Manufactures." *Weltwirtschaftliches Archiv* 114 (2), pp. 275-296.

Azhar, A and R.J. Elliot, (2003) "On the Measurement of Trade-Induced Adjustment." *Weltwirtschaftliches Archiv* 139 (3), pp. 419-439.

Balassa, B. (1965) "Trade Liberalisation and "Revealed" Comparative Advantage." *The Manchester School* 33 (2), pp. 116-117.

Bergstrand, J. (1982) "The Scope, Growth, and Causes of Intra-Industry International Trade." *New England Economic Review*.

Boring, A. (2012) "Offshoring Production and Intra-industry Trade." 3, pp. 102-27. https://www.etsg.org/ETSG2012/Programme/Papers/471.pdf

Brülhart, M. (1994). "Marginal Intra-Industry Trade: Measurement and Revelance for the Pattern of Industrial Adjustment" *Weltwirtschaftliches Archiv* 130 (3), pp. 600–613.

Brülhart, M. (2002) 'Marginal intra-industry trade: Towards a measure of non-disruptive trade expansion', *Frontiers of Research in Intra-Industry Trade*, pp. 109–130. doi:10.1057/9780230285989_7.

Brülhart, M. and R.C. Hine, (1999) 'Intra-industry trade and Adjustment', *The European Experience* [Preprint]. doi:10.1007/978-1-349-27173-3.

Brülhart, M. and R.J. Elliott, (2002) 'Labour-market effects of intra-industry trade: Evidence for the United Kingdom', *Centre for Research on Globalisation and Labour Markets*, 138(2), pp. 207–228. doi:10.1007/bf02707742.

Culem, C. and L. Lundberg. (1986). "The Product Pattern of Intra-Industry Trade: Stability among Countries and over time." *Weltwirtschaftliches Archiv* 122 (1). pp. 113-130.

Neven, J. Damien, A. Jacquemin, V. Norman. (1990). 'EEC integration towards 1992: Some distributional aspects', *Economic Policy*, 5 (10), p. 13. doi:10.2307/1344575.

Davies, R. (1978) 'Trade overlap and intra-industry trade: Comment', *Economic Inquiry*, 16(3), pp. 470–473. doi:10.1111/j.1465-7295.1978.tb00519.x.

Dixon, B., and J. Menon (1997) "Measures of Intra-industry Trade as Indicators of Factor Market Disruption." *Economic Record* 73, no. 222, pp.233–47.

Dutta, S. (2022). Two Approaches of Measuring Intra-industry Trade. Cambridge Open Engage. doi:10.33774/coe-2022-ttphh

Fertő, I., and K. Á. Soós (2020). "Intra-industry Trade in Agricultural and Food Products in the Central European Countries." *Studies in Agricultural Economics* 122 (2), pp. 86-93.

Finger, J. M. (1975) "Trade Overlap and Intra-Industry Trade." *Economic Inquiry* 13, no. 4 pp. 581–89. https://doi.org/10.1111/j.1465-7295.1975.tb00272.x.

Fontagné, L., AND M. Freudenberg. (1997). "Intra-Industry Trade: Methodological Issues Reconsidered." *Working Papers, CEPII research center*, https://econpapers.repec.org/scripts/showcites.pf?h=repec:cii:cepidt:1997-01.

Greenaway, D. Hine, R. Milner, C. and Elliot, R. (1994) "Adjustment and the Measurement of Marginal Intra-Industry Trade. *Weltwirtschaftliches Archiv* 130 (1), ppd. 418–427.

Greenaway, D., and C. Milner. (1981) "Trade Imbalance Effects in the Measurement of Intra-Industry Trade." *Weltwirtschaftliches Archiv* 117, no. 4, pp. 756–62.

Greenaway, D., and C. Milner. (1986) "The Economics of Intra-Industry Trade." *Journal of International Economics* 23, no. 1–2 pp. 182–85.

Greenaway, D., and C. Milner. (1987) "Intra-Industry Trade: Current Perspectives and Unresolved Issues." *Review of World Economics* 123, no. 1, pp. 44–45. https://doi.org/10.1007/bf02707781.

Greenaway, D., and C. Milner. (2003) "What Have We Learned from a Generation's Research on Intra-Industry Trade?" *The International Trade Journal* 17 (3): 309-343.

Greenaway, D., C. Milner. (1987). Intra-industry trade: Current perspectives and unresolved issues. *Weltwirtschaftliches Archiv* 123, pp. 39–57. https://doi.org/10.1007/BF02707781

Greenaway, D., Hine, R. and Milner, C. (1995) 'Vertical and horizontal intra-industry trade: A cross industry analysis for the United Kingdom', *The Economic Journal*, 105(433), p. 1505. doi:10.2307/2235113.

Grubel, H. G., and P. J. Lloyd. (1971) "The Empirical Measurement of Intra-industry Trade." *Economic Record* 47, no. 4, pp. 494–517. https://doi.org/10.1111/j.1475-4932.1971.tb00772.x.

Grubel, H. G., and P. J. Lloyd. (1975) "Intra Industry Trade - The Theory and Measurement of International Trade in Differentiated Products." *The Economic Journal*, pp. 1. https://doi.org/DOI: 10.2307/2230917.

Gullstrand, J. (2002) "Does the Measurement of Intra-Industry Trade Matter?" *Weltwirtschaftliches Archiv* 138, no. 2, pp. 317–39.

Hansson, P. (1989) "Intra-Industry Trade: Measurement, Determinants and Growth – A Study of Swedish Foreign Trade." *Umea Economic Studies* No. 205, pp. 1-24.

Hayakawa, K. A., T. B Ito, and T. C. Okubo. (2017) "On the Stability of Intra-Industry Trade." Journal of the Japanese and International Economies Volume 45, pp. 1–12. https://doi.org/10.1016/j.jjie.2017.05.001

Hosein, R. and R. Seecharan (2013) "Intra Industry Trade Measurement: Then and Now - Towards A New Measure of Marginal Intra Industry Trade." *The Special Issue on Contemporary Research in Business and Social Science,* Special Issue – July 2013, 4, no. 8.

IMF Staff. (2001). "Global Trade Liberalization and the Developing Countries." Issues Brief for November 8, 2001. https://www.imf.org/external/np/exr/ib/2001/110801.htm

Kalbasi, H. (2003) "Intra-Industry Trade and Trade Complementarity: The Case of East Asian Economies." Presented at the EcoMod Conference. https://ecomod.net/sites/default/files/document-conference/ecomod2003/Kalbasi.pdf.

Krugman, P. R. (1979) "Increasing returns, monopolistic competition, and international trade" *Journal of International Economics,* Elsevier, vol. 9(4), pp. 469-479.

Lloyd, P. J. (1998) "Globalisation, International Factor Movements and Market Adjustments." EconStor, CREDIT Research Paper, No. 98/7, Working Paper. https://www.econstor.eu/bitstream/10419/81829/1/98-07.pdf

Loertscher, R. and F. Wolter. (1980) "Determinants of Intra-Industry Trade: among countries and across industries." *Weltwirtschaftliches Archiv* 116 (2), pp. 280-293.

Luka, O. and Levkovych, I. (2004) Intra-industry trade in agricultural and food products: the case of Ukraine, Discussion Paper, No. 78, Institute of Agricultural Development in Central and Eastern Europe (IAMO), Halle (Saale) https://www.econstor.eu/bitstream/10419/28465/1/49215502X.pdf

Mercan, M., and H. Yergin. (2012) "Analysis of Intra-Industry Trade Between Turkey- Bosnia and Herzegovina and Alternative Index." *International Journal of Business and Social Science* 3, no. 1.

MTI. (2021) "Government Committed to Resurgence in Manufacturing" Ministry of Trade and Industry.https://tradeind.gov.tt/government-committed-to-resurgence-in-manufacturing/.

Mukerji, P., and A. Panagariya. (2019) “Investigating the Composition of Product-Level Specialization.” *Indian Economic Review* 54, no. 1, pp. 3–18.

Nilsson, L. (1997) “The Measurement of Intra-Industry Trade between Unequal Partners.” *Weltwirtschaftliches Archiv* 133, no. 3, pp. 554–65.

Nilsson, L. (1999) “Two-Way Trade between Unequal Partners: The EU and the Developing Countries.” *Weltwirtschaftliches Archiv* 135, no. 1, pp. 102–27. https://doi.org/10.1007/bf02708161.

Njegovan, N. (2021) “Trade Imbalance Effects in The Measurement of Intra-Industry Trade In Agricultural Products.” Essay in *Sustainable Agriculture and Rural Development*, 271–78. Belgrade: Institute Of Agricultural Economics.

Ottaviano, G.I.P., D. Taglioni, AND F. Di Mauro. (2009) ‘The euro and the competitiveness of European firms’, *Economic Policy*, 24 (57), pp. 5–53. doi:10.1111/j.1468-0327.2009.00216.x.

Rahman, A. (1986) “Réexamen de la Definition et de la Mesure des Echanges Croisés de Produits Similaires entre les Nations.” *Revue Economique* 37 (1), pp. 89-115.

Rajan, R. S. (1996) *Weltwirtschaftliches Archiv* Bd. 132, no. H. 2, pp. 378–89.

Ricardo, D. (1817) “The principles of political economy and taxation.” *Homewood, IL: Irwin.*

Ruffin, R. J. (1999) “The Nature and Significance of Intra-Industry Trade.” *Economic and Financial Policy Review*, Federal Reserve Bank of Dallas, Q IV, pp. 2-9.

Seecharan, R. (2013) “Intra Industry Trade Measurement: Then and Now-Towards A New Measure of Marginal Intra Industry Trade.” *Semantic Scholar* https://www.semanticscholar.org/paper/Intra-Industry-Trade-Measurement-%3A-Then-and-A-New-Seecharan/58bb8aa1c2582ccf0396e136f5abd78335625fa2

Shelburne, R. C. (1993) “Changing Trade Patterns and the Intra-Industry Trade Index: A Note.” *Weltwirtschaftliches Archiv* 129 (4), pp. 829–833.

Silgoner, M. A., and K. Steiner. (2019) "The Dynamics of Intra-Industry Trade by Technology Intensity: The Case of Austria." *Empirica* 46 (2), pp. 283-303.

Södersten, B, and G. Reed. (1994) “Intra-Industry Trade.” *International Economics*, pp. 146–72. https://doi.org/10.1007/978-1-349-15030-4_8.

Suranovic, S. (2012) “International Trade: Theory and Policy” v. 1.0, Saylor Academy. https://saylordotorg.github.io/text_international-trade-theory-and-policy/s08-the-heckscher-ohlin-factor-pro.html

Venables, A, A. Smith, P. Krugman, R. Kanbur. (1986) ‘Trade and industrial policy under Imperfect Competition’, *Economic Policy*, 1 (3), p. 621. doi:10.2307/1344585.

Vona, S. (1991) "On the Measurement of Intra-Industry Trade: Some Further Thoughts." *Weltwirtschaftliches Archiv* 127, no. 4, pp. 678–700. https://doi.org/https://doi.org/10.1007/BF02707415.

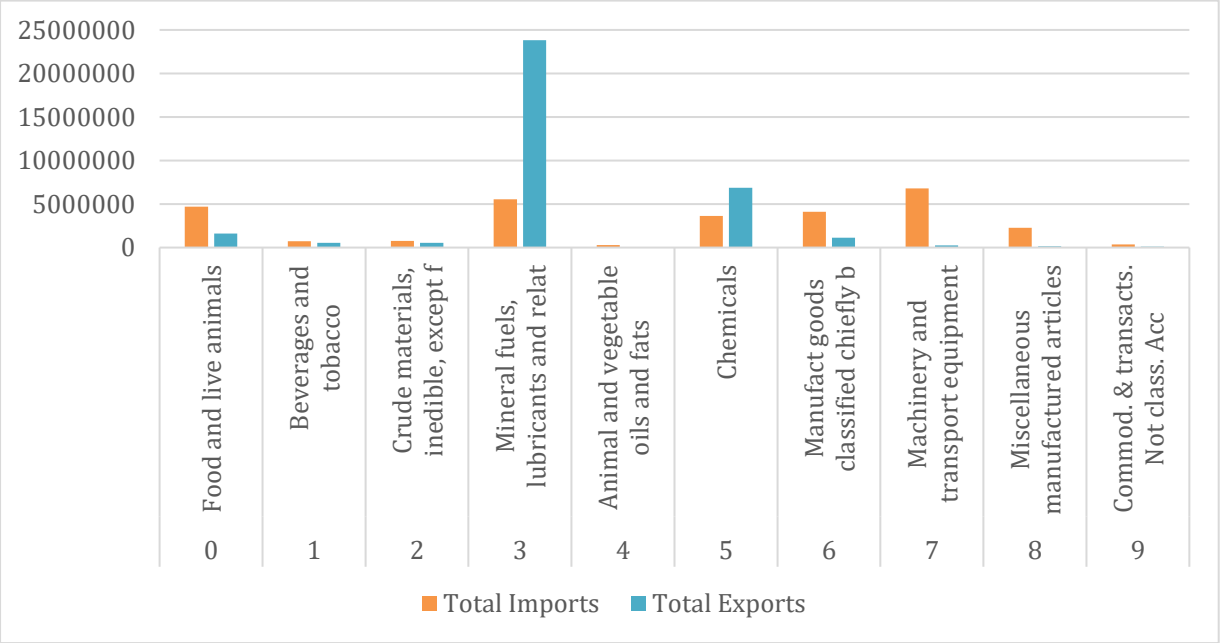
Weder, R. (1995). "Linking absolute and comparative advantage to intra-industry trade theory." *Review of International Economics* 3 (3), pp. 342-354. 10.1111/j.1467-9396.1995.tb00076.x

Wilen, S. (2022) "How Competition Impacts International Trade, ATI News." https://www.american-trading.com/news/how-competition-impacts-international-trade

Yamaguchi, S. (2018). "International Trade and the Transition to a More Resource Efficient and Circular Economy: A Concept Paper", *Trade and Environment Working Papers, OECD Publishing, Paris.*

Appendix

Figure A1. CARICOM imports and exports of the world by (1-Digit) product group for 2022.



Note: *X* axis showing total imports and exports, y axis showing total trade value in USD$, WITS.

Figure 1 shows that exports were higher than imports for CARICOM for the year 2022 only. As such, figure A1 above provides a breakdown of CARICOM's trade flows by SITC 1-digit and demonstrates that for 2022, higher total exports were because of increased trade in mineral fuels, lubricants and related goods.