Synthesis of the Indices used to Measure Intra-industry Trade

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Abstract: This paper aims to synthesize the indices used in the academic literature for the measurement of intra-industry trade. To do this, a review of works indexed in the Scopus bibliographic index and in the bibliographic bases Science Direct, Scielo, SSRN and REPEC will be carried out in three languages: English, Spanish and Portuguese, between 1960 and 2016.

Keyword: Intra-industry trade, economic growth, horizontal intra-industrial trade, intra-industrial vertical trade.

1. INTRODUCTION

The gains from intra-industry trade (CII) are generally higher than those arising from inter-industry trade, because they include benefits related to economies of scale, technological externalities, positive linkages with the rest of the economy, increasing returns Dynamics, among others ([1], [2]). This pattern of trade favors the addition of value and has a strong impact on the growth of economies ([3], [4]), although some authors have also warned of its potential damages [5].

The IIC was defined as the trade of goods and services with similar characteristics between one or more countries ([6]). Table 1 presents the characteristics of the IIC, which were established by the Organization for Economic Cooperation and Development (OECD). From them, the IIC would be expected to be more common in highly developed industrial countries, but it is not an indispensable situation.

However, the exchange of specialized manufactured goods based on the differentiation and fragmentation of the value chain has allowed the growth of the IIC to lead to productive chains that could lead to economic growth ([7]). In the countries most open to the international market, the IIC has a high participation. The existence of the IIC can be evidence of a simultaneous specialization of both trading partners and allow each of these economies to enhance the expansion of activities with high value-added content within them ([8]). On the other hand, the degree of trade openness and preferential trade agreements have a significant influence on the growth of the

IIC. It has been observed that flows of this type of trade have performed well in some developing countries, accompanied by processes of trade liberalization and deepening regional integration ([7], [2], [4], [9]).

Another important element in the IIC's analysis is the role played by intra-firm trade, in which multinational companies have been protagonists in the process of globalization and in the internationalization of production chains ([10], [11]). In some studies intra-firm trade is associated with a part of the IIC, however, intra-firm trade does not necessarily occur between related companies operating in the same segment of an industrial arm, since there is no full correlation between the two forms of trade.

Table 1
Characteristics of the IIC in agreement with the OECD

Characteristic	*Explanation*
Products based on differentiation and fragmentation	Specialized manufactured products based on the differentiation and fragmentation of the value chain.
Export opening rate and penetration rate of high imports	In countries where imports and exports account for more than half of the Gross Domestic Product, the IIC is particularly high.
Preferential Trade Treaties and High FDI Flows	The IIC is highly related to foreign direct investment flows and closely linked to preferential trade agreements.
Intra-firm trade	Intra-firm trade (between subsidiaries in different geographic locations) based on the differentiation or fragmentation of the product largely cements the IIC.

Source: Self made

However, the IIC in horizontal and vertical (Graph 1), which are associated with the types of product differentiation. The first is linked to the differentiation of goods by their secondary attributes, the presence of economies of scale and imperfect competition schemes. In this type of trade, consumers gain gains in variety and lower adjustment costs, albeit with unpredictable welfare effects ([12]). It arises when two independent production chains belonging to the same industry and with similar levels of development exchange their products at the international level ([10], [13]).

For its part, the vertical IIC corresponds to goods that differ by quality, is derived from relative factor endowments and trade gains. In this case, the redistributive effects are explained in the same way as the traditional models of international trade (12). It occurs when the same production line is located in different countries, being carried out a reexportation of goods ([10]). The quality of goods in the latter type of trade may be high or low according to the proportion of capital and labor necessary for their production, and the demand for them is determined by the income differences between consumers (14). Empirical evidence suggests that most of the IIC is of this type, which implies that the varieties exchanged between the different countries correspond to different quality levels ([15]).
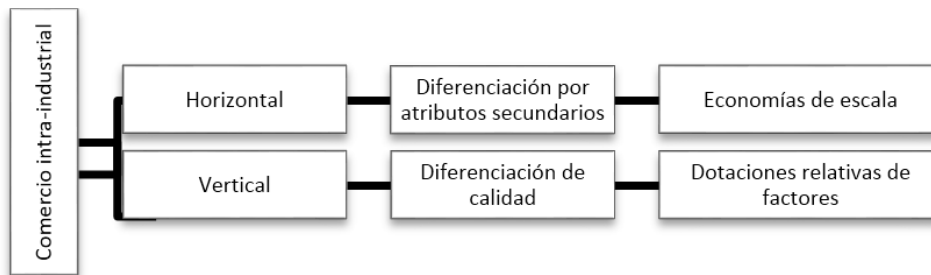

Figure 1: Typology of the IIC

In this scenario, the purpose of this paper is to question what are the indices used to measure intra-industry trade?

2. METHODOLOGY

In order to synthesize the indices used to measure intra-industry trade, a literature review was carried out, following the following protocol, following the scheme of systematic reviews: (i) identification of the field of study, subject and period a analyze; (ii) formulating the problem; (iii) definition of search criteria for information; (iv) selection of references and studies; (v) critical reading and risk assessment of bias in included studies; (vi) extraction of relevant information and data; (vii) analysis and synthesis of scientific evidence.

The sources used corresponded to works indexed in the Scopus bibliographic index and the bibliographic bases Science Direct, Scielo, SSRN and REPEC, in three languages: English, Spanish and Portuguese, in the period 1960-2016.

3. RESULTS

The indexes used for the measurement of intra-industry trade and their limitations are summarized below (Table 2).

Table 2
Indexes for measuring IC

Index	Description	Reviews
Indexes of Balassa (1966) [16]	It measures the extent to which the absolute quantity of commodity exports (X_i) corresponds to imports (M), at a particular level of aggregation, by $$\text{Bi} = \frac{\left| X_i - M_i \right|}{\left| X_i - M_i \right|}, \text{ where } 0 < \text{Bi} < 1.$$ The degree of intra-industrial specialization is measured $B = \dfrac{1}{n} \sum_{i=1}^{n} \text{Bi}$	Grubel and Lloyd criticized this index because it is a simple arithmetic mean of the index of each industry and does not take into account the correction of global trade imbalances.
Unadjusted Grubel and Lloyd Indicator	The first version of the Grubel and Lloyd indicator for a sector j is: $$\text{GL}_j = \left[1 - \frac{\left| X_j - M_j \right|}{(X_j + M_j)} \right] \times 100$$ X_j y M_j Are exports and imports in the ith sector. $0 < \text{GL}_j < 100$ if its value is zero there is no CII in the sector and if it is 100 the whole trade is intra-industrial.	[17] raised with respect to this index that is biased to a low IIC measure in the event of a trade imbalance, since they can not reach their maximum value because exports and imports can not be matched in all industries.
Adjusted indicator of Grubel and Lloyd (1971, 1975) [17] [19]	The adjusted indicator is: $$\overline{\text{GL}} = \frac{\sum_{1=1}^{n}(X_i + M_i) - \sum_{1=1}^{n}|X_i + M_i|}{\sum_{1=1}^{n}(X_i + M_i) - \left| \sum_{1=1}^{n} X_i + \sum_{i=1}^{n} M_i \right|}$$ This measure applies to aggregate trade flows only and does not have a counterpart at the level of an individual industry. When this indicator equals 1, it is independent of the size of these trade imbalances. For all i, if total exports had been equal to total imports.	There is a problem of categorical aggregation, since the error associated with the measurement is related to an erroneous grouping and resulting in an overestimation of the volume of CII [18].
Measure of Aquino (1978) [20]	This measure seeks to correct the general imbalance at the elementary level. It makes multilaterally manufactured trade disequilibrium as a basis for correction. The indicator is given by: $$Q_j = \frac{\sum_{1=1}^{n}(X_{ij} + M_{ij}) - \sum_{1=1}^{n}\left| X_{ij}^e - M_{ij}^e \right|}{\sum_{1=1}^{n}(X_{ij} + M_{ij})} \times 100$$	

Index	Description	Reviews
Correction Balassa (1979) [23]	According to [23] [24] Aquino's correction, but allows between industrial specialization between primary and manufactured goods unlike Aquino where the balanced trade of manufactures is achieved with the correction of Aquino. The correction is given by X_i and M_i, ie the value of exports and imports at the industry level Balassa defines: $$X_i^b = X_i \frac{(X+M)}{2X}, M_i^b = M_i \frac{(X+M)}{2X}$$	[20], criticizes that the elemental measure GLi, at the most disaggregated level, is also biased downwards as GL.
Bergstrand Index (1983) [25]	[25] is in favor of Balassa's correction and ignores the Aquino index and proposes an iterative procedure to adapt bilateral unbundled trade flows to make them consistent with the multilateral global trade balance. The index is given by: $$IIT_{ij}^{k*} = \frac{1 - \left(\left\| X_{ij}^{k*} - X_{ji}^{k*} \right\|\right)}{X_{ij}^{k*} + X_{ji}^{k*}}$$ X_{ij}^k = Exports from i country to j of industry k $X_j = \sum_k \sum_j X_{ij}^k$. Exports of everything i to all j in goods k $M_i = \sum_k \sum_j X_{ji}^k$. Imports of everything i to all j into goods k And similarly we interpret X_j and M_j The amount of IIC depends on how third countries are added and on Balassa's correction. Now for a country with total balance of payments balance, individual sub-accounts may not be in balance.	
Index Adjusted Gl of Greenaway and Milner (1983) [18]	According to [18] to verify if there is a categorical aggregation error, the GyL index must be calculated for different levels of aggregation in a specific classification, from the indicator C_j, which is an average of the weighted indexes of the subgroups: $$C = \left(1 - \frac{\sum \left\| X_{ij} - M_{ij} \right\|}{\sum \left(X_{ij} + M_{ij}\right)}\right) \times 100$$ Where, X_{ij} and M_{ij} are exports and imports in subsector i belonging to sector j. The higher the level of disaggregation the lower the value of C.	[21], [22] argue that there can be no a priori justification for bringing balance to the multilateral equilibrium on manufactured trade.
Vona (1990) [28]	[28] states that the adjusted GL index is a measure of similarity in the trade composition and shows that this measure has no relation to the pattern of trade that actually takes place at that specific level, but depends on the Intersectoral composition of trade flows. These deficiencies suggest that it is not an adequate measure of intra-industry and therefore GL (U) is an appropriate measure of this type of trade. $$GK(U) = \frac{\sum_{i=1}^{n}\left(X_i + M_i\right) - \sum_{i=1}^{n}\left| X_i - M_i \right|}{\sum_{i=1}^{n}\left(X_i + M_i\right)} \cdot 100$$	

Index	Description	Reviews
Lloyd Grubel dynamic index [29]	Lloyd Grubel dynamic index ([29]) is given by: $$\mathrm{IIT}_{ij}t = 1 - \frac{\sum_{i \in A}\sum_{j \in A}\sum_{k=1}^{n}\Delta X_{ij}kt - \sum_{i \in A}\sum_{j \in A}\sum_{k=1}^{n}\Delta M_{ij}kt}{\sum_{i \in A}\sum_{j \in A}\sum_{k=1}^{n}\left|\Delta X_{ij}kt\right| + \sum_{i \in A}\sum_{j \in A}\sum_{k=1}^{n}\left|\Delta M_{ij}kt\right|}$$ Where D refers to the first degree differentiation and $X_{ij}kt$ and $M_{ij}kt$ represent the exports and imports of the Kt, *h*, sub-industries in period *t*, respectively. $$\sum_{i \in A}\sum_{j \in A}\sum_{k=1}^{n}\Delta X_{ij}kt - \sum_{i \in A}\sum_{j \in A}\sum_{k=1}^{n}\Delta M_{ij}kt$$ Denotes the absolute change in net trade $$\sum_{i \in A}\sum_{j \in A}\sum_{k=1}^{n}\left|\Delta X_{ij}kt\right| + \sum_{i \in A}\sum_{j \in A}\sum_{k=1}^{n}\left|\Delta M_{ij}kt\right|$$ Represents the change in total trade between the two regions. IITijt refers to the dynamic CII index for all subsectors *k* between region *i* and region *j* in period *t*, where $\mathrm{IIT}_{ij}t$ (0, 1). Another measure of Brülhart, called the B index, is defined as $$\mathrm{Bi} = \frac{\Delta Xi - \Delta Mi}{\left(\left|\Delta Xi\right| + \left|\Delta Mi\right|\right)}$$ And is related to the index as A $\mid$ Bi $\mid$ = 1 − Al. Values between − 1 and 1 are taken, with values close to zero indicating CII. Brülhart's final index, the C index, gives information on changes in the IIC level. In fact, it is only the numerator Of the index A: C$i = \mid \Delta Xi \mid + \mid \Delta Mi \mid - \mid \Delta Xi - \Delta Mi \mid$ If the objective is also to measure the degree of adjustment needed after trade liberalization, the C index would fulfill this function. However, it only gives information on the coincident changes in trade.	
Correction of Fontagné and Freudenberg (1997) [27]	As a corrective measure to geographical bias, it is proposed to always calculate on a bilateral basis and then add the results of the indicator: $$C_{r,ij} = 1 - \frac{\sum_{r=1}^{R}\sum_{i=1}\left|X_{ij} - M_{ij}\right|}{\sum_{r=1}^{R}\sum_{i=1}(X_{ij} - M_{ij})} \times 100$$ Where *r* represents a country belonging to region R. In CEPII methodology proposed by these authors, the total flow is classified into one of three categories: 1. Two way trade in similar products 2. Two-way trade in vertically differentiated products 3. One way trade. The purification of significant trade flows is done in order to classify them into one of three categories: if the minority flow represents at least 10% of the majority flow, it is classified in two-way trade and its nature and quality are evaluated. If this condition is not met, the flow of trade is considered one-way trade	

Source: own elaboration based on [30], [31], [32] and the documents cited in the table.

The indexes used to identify the type of CII are horizontal or vertical and in case of being horizontal if it is high or low quality are shown in Table 3.

Table 3
Indexes used for IIC unbundling

Author	Index	Classification
Greenaway (1995) [21]	(C_j), can be disaggregated into the horizontal CII index and the vertical CII index. $$CII(Z)_j = \left\{ \frac{\sum X_{ij}^z + M_{ij}^z}{\sum \left(X_{ij} + M_{ij} \right)} \times \left(1 - \frac{\sum \left| X_{ij}^z - M_{ij}^z \right|}{\sum X_{ij}^z + M_{ij}^z} \right) \right\} \times 100$$	Z refers to the horizontal or vertical nature of the IC
Greenaway (1995) [21]	To disaggregate the horizontal type IC in high and low quality: X_{ij}^w and M_{ij}^w are exports and imports classified as vertical, w refers to the quality $$CIIV(w)_j = \left\{ \frac{\sum_i \left| X_{ij}^w + M_{ij}^w \right|}{\sum_i \left(X_{ij} + M_{ij} \right)} \left[1 - \frac{\sum_i \left| X_{ij}^w - M_{ij}^w \right|}{\sum_i \left(X_{ij}^w + M_{ij}^w \right)} \right] \right\} \times 100$$ For these indices in the j-th sector requires the discrimination of their respective sub-sectors according to their nature. The unit values of exports and imports are used. These are approximate measures of the price level of a specific basket of goods. The unit values are constructed as follows: $$VU_{ij} = V_{ij}/Q_{ij}$$ Where VU_{ij} is the unit value, V_{ij} is the value of the n operations carried out under the subsector i of industry j and Q_{ij} is the quantity traded in the n operations carried out under the subsector i of industry j. Then it is calculated $\dfrac{VU_{ij}^x}{VU_{ij}^m}$	The following criteria are used for the classification of the horizontal and vertical subsectors: The subsectors with horizontal CI are the subsectors i belonging to sector j, satisfy. $$1 - \alpha \le \frac{VU_{ij}^x}{VU_{ij}^m} \le 1 + \alpha$$ Where α is a scattering factor that can take the value of 0.15 or 0.25. For discrimination of the nature of the IC, an $\alpha = 0.25$ is used. The subsectors with low quality vertical IC are the subsectors i in sector j where: $$\frac{VU_{ij}^x}{VU_{ij}^m} \prec 1 + \alpha$$ And the subsectors of high quality vertical IC satisfy: $$\frac{VU_{ij}^x}{VU_{ij}^m} \succ 1 + \alpha$$
Lloyd, Grubel [29] [31]	Following definitions by Brulhart (1994) and Thom and McDowell (1999) The horizontal IIC is given by: $$IITH_{ij}t = \sum_{k=1}^{n} W_k \, B_{ij}kt$$ And W_k is given by: $W_k = \left| \Delta X_k \right| + \left| \Delta M_k \right| \Big/ \sum_{k=1}^{n} \left| \Delta X_k \right| + \sum_{k=1}^{n} \left| \Delta M_k \right|$ Implies the relation between the branch of order kth for all n Sub-industries $$B_{ij}kt = 1 - \frac{\left| \Delta X_{ij}kt - \Delta M_{ij}kt \right|}{\left| \Delta X_{ij}kt + \Delta X_{ij}kt \right|}$$ Represents the variations in exports and imports of the order k, sub-sector between region i and region j in period t. Thus, $VIIT_{ij}t = IIT_{ij}t - HIIT_{ij}t$	

Source: Own elaboration based on [31] and [33].

4. CONCLUSION

After the literature review on the IIC, it was possible to identify that the traditional indexes of Lloyd Grubel, Greenaway and Milner and Fontagné and Freudenberg, are still used, despite a great diversity of later developments.

The aforementioned indices continue to be of great importance in the empirical studies, since they are a previous phase of identification of industrial sectors and branches, the use of econometric techniques and economic modeling.

Also, it was possible to identify in the literature that while this may lead to higher growth rates, when it is done between nations with different levels of development, the IIC is not based on economies of scale but on product differentiation. Likewise, there are conditions such as intra-firm trade, economies of scale and factorial endowment, which in isolation may not lead to higher levels of CII.

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