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## **Intra-Industry Trade and Revealed Comparative Advantage: An Inverted-U Relationship**

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**Abstract:** This paper investigates the relationship between all types of intra-industry trade (IIT) and comparative advantage. The paper finds strong evidence of an inverted-U relationship. The results also suggest that relative autarky costs is a common determinant for any type of IIT, which contradicts the prediction made by theory for separating the determinants of horizontal and vertical IIT.

**Key words:** intra-industry trade, horizontal intra-industry trade, vertical intra-industry trade, comparative advantage.

**JEL Subject Code:** F1, C0, C2.

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## I. Introduction

In this paper we calculate the Grubel and Lloyd's intra-industry trade (IIT) index of the forty main products for the bilateral trade between Portugal and Spain. We also have calculated Balassa's revealed comparative advantage (RCA) index for the same products for the same period (1990-1999)<sup>1</sup>. As the analysis is made at the product level it was more adequate to say intra-product trade (IPT) than IIT. We make a distinction between horizontal intra-industry trade (HIIT) and vertical intra-industry trade (VIIT) and we use a regression model to test the relationship between IIT, HIIT and VIIT, on the one hand and RCA, on the other hand.

In the last decade the relationship between comparative advantage and IIT has been questioned. The new international trade theory have long been interested in the relationship between comparative advantages and IIT. Flam and Helpman (1987), Davis (1995) demonstrate that VIIT can be explained theoretically by traditional trade models (Ricardo and HO models). So, there is a relationship between comparative advantage and VIIT. Can we say the same about the relationship between IIT and RCA and between HIIT and RCA?

As the Heckscher-Ohlin model can explain VIIT and has an underlying hypothesis that goods are produced under different factor proportions and are exported according to comparative advantages (HO theorem), it is expected that we will find a positive correlation between VIIT and revealed comparative advantage (RCA) and a negative correlation between HIIT and RCA. About the correlation between total IIT and RCA there is no expected sign because total IIT includes both HIIT and VIIT. However, following Linder's hypothesis and Helpman and Krugman (1985 model the correct sign seems to be the negative one.

However we think that the relative autarky cost are always an important determinant of all trade, during a certain period of product life. After a certain period of time, when the product becomes mature and the production process is familiar to producers (Vernon's product cycle theory) it will expected that the influence of RCA

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<sup>1</sup> For the purposes of the paper the period of time is not very important. The most important is the level of disaggregation in order to calculate reliable IIT indices.

on all types of IIT declines. In this stage of the product life cycle there are other determinants (like foreign direct investment, product differentiation). So the relationship between all types of IIT and comparative advantage can be expressed by a parable, i.e. an inverted U shaped relationship.

Although we have used a simple quadratic function, parable, without control variables, there is empirical evidence confirming this hypothesis. The results also suggest that relative autarky costs is a common determinant for any type of IIT, which seems to contradict the idea that VIIT and HIIT have different determinants. At least, this deserves further investigation.

The remainder of the paper is organized as follows. Section 2 presents the theoretical background and the revisited empirical work on IIT. Section 3 presents the methodology. Section 4 presents the econometric models and analyzes the estimation results. The final section concludes.

## **II. Theoretical Literature**

The pioneering work in intra-industry (IIT) models is due to Krugman (1979,1980), Lancaster (1980), Helpman(1981) and Eaton and Kierzkowski(1984). All these models consider that products are horizontally differentiated – different varieties of a product are of a similar quality - although the varieties of the same product may be distinguished in terms of their actual characteristics or perceived characteristics. Neo-Chamberlinian models, such as Krugman models, consider the assumption that all varieties enter the utility function symmetrically. By contrast, the neo-Hotelling model, for example the Lancaster model, assumes asymmetry. In the former, the consumers are assumed to endeavor to consume as many different varieties of a given product as possible (“love of variety approach”). In the latter, different consumers have different preferences for alternative varieties of a given commodity and each consumer prefers one variety to all others (“favorite variety approach”). In these models each variety is produced under decreasing costs and when the countries open to the trade the similarity of the demands leads to intra-industry trade. Horizontal IIT (HIIT) is more likely between countries with similar factor endowments and may assume identical factor intensity. So, HIIT could not be explained by traditional trade theories.

In the vertical differentiation, different varieties are of different qualities and it is assumed that consumers rank alternative varieties according to product quality. Falvey (1981)<sup>2</sup>, Falvey and Kierzkowski (1984), Shaked and Sutton (1984) and Flam and Helpman (1987) introduced the vertical differentiation models. It is generally accepted that vertical IIT (VIIT) can be explained by traditional theories of comparative advantage. (Greenaway and Milner 1986, Greenaway, Hine and Milner 1994, 1995<sup>3</sup>, Tharakan and Kerstens 1995, Blanes and Martin 2000). The relative labor abundant countries have comparative advantage in labor-intensive products (lower quality varieties) and relative capital abundant countries have comparative advantage in capital-intensive products. So, according to comparative advantage, the first countries will export the labor-intensive varieties and the other countries will export the capital-intensive varieties. Or in terms of the factor content version of Heckscher-Ohlin theorem for  $n$  goods and factors: the capital content of the net exports of the relative capital abundant country will be higher in relationship to the net exports of the other country (Vanek, 1968). There is an assumption that “goods are distinguished on the demand side according to perceived quality, and on the production side by the fact that high quality goods are produced under conditions of greater capital intensity” (Davis, 1995:205). So, we exclude from VIIT goods (varieties) produced under the same factor proportions.

The new theory of international trade changed the views about traditional theories of comparative advantage (Ricardian trade theory and Heckscher-Ohlin trade theory). Helpman and Krugman (1985) build up a model which generates both inter and horizontal intra-industry trade. The model incorporates factor endowments, decreasing costs and horizontal product differentiation. So, it is known as the Chamberlin-Heckscher-Ohlin model. Davis (1995) provides a Heckscher-Ohlin-Ricardo framework that gives a unified account of inter-industry and intra-industry trade and where decreasing costs are not necessary for intra-industry trade.

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<sup>2</sup> Falvey (1981) explains the simultaneous existence of vertical IIT and inter-industry trade.

<sup>3</sup> Greenaway, Hine and Milner (1995) refers to four types of model of IIT in differentiated products “(i) large numbers case of vertical IIT (e.g. Falvey, 1981); (ii) small numbers case of vertical IIT (e.g. Shaked and Sutton, 1984); (iii) large numbers case of horizontal IIT (e.g. Helpman, 1981); (iv) small numbers case of horizontal IIT (e.g. Eaton and Kierzkowski, 1984)”. There are also some models of IIT in homogeneous products (e.g. Brander, 1981; Brander and Krugman, 1983).

As the Heckscher-Ohlin model can explain VIIT and has an underlying hypothesis that goods are produced under different factor proportions, it is expected that we will find a positive correlation between VIIT and revealed comparative advantage (RCA) and a negative correlation between HIIT and RCA. About the correlation between total IIT and RCA there is no expected sign because total IIT includes both HIIT and VIIT.

The Linder theory of overlapping demands suggests that goods must first be produced for home markets and then exported to similar countries. According to Linder's (1961) hypothesis, a negative relationship between income differences and IIT is to be expected. Linder's (1961) theory can also explain VIIT. The less developed countries with low per-capita incomes specialize in, and export, low-quality products (varieties), whereas the developed countries with high per-capita incomes specialize in, and export, high-quality products (varieties of the same product). So, Linder's theory proposes that the higher the difference in per-capita income, the greater the VIIT.

Linder's theory is consistent with some aspects of the product cycle theory developed by Vernon (1966). Vernon's theory divides the life cycle of the new product into three stages: new product stage, maturing product stage and standardized product stage. The country source of exports shifts throughout the life cycle of the product and the foreign direct investment (FDI) has a decisive role in this dynamic process. In the last product stage, the technology becomes available to the less-developed countries through the FDI. This allows these countries to export low-quality differentiated products to the developed countries, importing at the same time the high-quality product varieties from these countries. So, Vernon's theory suggests a positive relationship between VIIT and per-capita income differences and between VIIT and FDI. Linder (1961) and other studies use per capita income differences as proxies for consumer tastes and preferences. It has been argued that as per capita incomes of two countries become equal, their tastes and preferences also become similar. Hence, the share of IIT rises as the difference in per capita declines. Helpman and Krugman (1985) consider differences in per capita as differences in the capital-labor ratio. Thus, there is an expected negative relationship between bilateral inequality in per capita GDP and the share of IIT. As the HO theorem states that a country will export goods that use relatively intensively the country's relatively abundant factor of production, i.e. the good where the country has the comparative

advantage, we can also expect a negative relationship between comparative advantage and IIT.

### III. Methodology

Below we present the Grubel and Lloyd intra-industry trade (IIT) index, as well as Balassa's RCA index used in this paper.

Grubel and Lloyd (1975: 20-23) define IIT as the difference between the trade balance of the industry or product  $i$ ,  $(X_i - M_i)$  and the total trade of this same industry or product  $(X_i + M_i)$ .

$$R_i = (X_i + M_i) - |X_i - M_i|$$

In order to make the comparison easier between industries or countries, the index is presented as a ratio where the denominator is the total trade.

$$IIT_i = \{[(X_i + M_i) - |X_i - M_i|] / (X_i + M_i)\}$$

The index for the main forty products will be:

$$IIT40 = \frac{\sum_{i=1}^{40} R_{ij}}{\sum_{i=1}^{40} (X_{ij} + M_{ij})}$$

Where  $j$  indicates the trade partner (Spain).

We applied Abd-el-Rahman(1991) and Greenaway et al. (1994) methodology to calculate the horizontal IIT index (HIIT) and vertical IIT index (VIIT) for the main forty products and for the period 1990-1999. Relative unit values of exports and imports are utilised to disentangle horizontal from vertical IIT. The underlying assumption is that relative prices tend to reflect differences in qualities. We used a unit value dispersion of 15 percent ( $\alpha = 0,15$ ).

The source used for constructing the indices was the INE - Portuguese National Institute of Statistics (Trade Statistics).

In the empirical analysis, we consider all the products at the five-digit level of the Combined Nomenclature (CN). In econometric analysis, the 5-digit product categories were aggregated to the 3-digit industry level, according to the Portuguese Classification of Economic Activities (CAE)<sup>4</sup>

The revealed comparative advantage (RCA) indexes of Bela Balassa are well known.( Cf., Balassa 1965,1967,1977).<sup>5</sup> The difference between the two indexes lies in the fact that one of them includes only exports whereas the other includes both exports and imports. We will use the second one.

The second index suggested by Balassa can be presented as follows:

$$RCA_{ij} = (X_{ij} / M_{ij}) / ( \sum_{i=1}^n \sum_{i=1}^n X_{ij} / \sum_{i=1}^n M_{ij} )$$

where  $M_{ij}$  are the imports of product  $i$  in country  $j$  and  $\sum_{i=1}^n M_{ij}$  are the world imports of this product.

The  $RCA_{ij}$  index represents the rate of coverage imports by exports of the product  $i$  divided by the rate of coverage imports by exports of all products traded in country  $j$ . Thus, if  $RCA_{ij}$  is higher than one, then product  $i$  has a positive effect upon  $j$ 's trade balance.

When we apply logarithms to the index and we have  $\ln RCA > 0$  then there are comparative advantages; by contrast, when  $\ln RCA < 0$  there are comparative disadvantages. However, this second index has a limitation: it would be systematically negative ( in log-terms) in economies which register a high total import/export ratio.

Finally, we use the econometrics models to test if there is a positive correlation between VIIT and RCA and a negative correlation between HIIT and RCA.

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<sup>4</sup> At this level of disaggregation, CAE is similar to NACE.

<sup>5</sup> Balassa (1965:105) justified his indices by stating that: "It is suggested here that "revealed" comparative advantage can be indicated by the trade performance of countries in regard to manufacturing products, in the sense that the commodity pattern of trade reflects relative costs as well as differences in no-price factors".



## IV. The econometric models

### IV.1. Model Specification

$$\ln IIT_{it} = \beta_0 + \beta_1 \ln RCA_{it} + \beta_2 (\ln RCA)^2_{it} + \varepsilon_{it}$$

Where  $IIT_{it}$  stands for either IIT, HIIT, or VIIT, meaning Total, Vertical or Horizontal Portuguese bilateral IIT index in the year  $t$ .  $\varepsilon_{it}$  is a random disturbance assumed to be normal, independent and identically distributed (IID) with  $E(\varepsilon_{it}) = 0$  and  $Var(\varepsilon_{it}) = \sigma^2 > 0$ .

We have three dependent variables: total IIT index, VIIT index, and HIIT index for the main forty products. As the explanatory variable we used the Balassa's revealed comparative advantage index (RCA). We consider that Balassa's RCA index reveals comparative advantage in terms of the difference of relative autarchy costs. The expected signal for the coefficient of this explanatory variable differs in accordance with the dependent variable. For VIIT model the expected signal is positive because VIIT is mainly due to H-O determinants. So the differences of relative autarchy costs between countries have a positive effect on VIIT (and we can consider the RCA differences a proxy for relative autarchy costs differences). If we consider HIIT the dependent variable, then the expected signal is negative because HIIT is mainly explained by the variables of the modern trade theory (economies of scale). If the dependent variable is total IIT, we can have positive or negative coefficients.

We used the variables in logarithm form in order to estimate the elasticities.

### IV.2. Analysis of the results

As we can see by Table 1, in all equations the coefficient of  $\ln VCR$  always has the same signal, the positive one and the adjustment is better when we use the polynomial model (higher  $R^2$ ). The quadratic function allows us to test the hypothesis that the relationship between the dependent variable ( $\ln IIT$ ,  $\ln HIIT$  or  $\ln VIIT$ ) and the explanatory variable ( $\ln RCA$ ) is an inverted U. So, as the hypothesis is confirmed,

we can say that all types of IIT are positive correlated with comparative advantages (RCA) up to a given value ( maximum) and then decrease. The effects of comparative advantage on all types of IIT are positive only for the lower values of RCA. When we consider the quadratic function the peak of the inverted U occurs at the following values of lnRCV (RCA):

- IIT equation:  $\ln RCA = 1,058$  (  $RCA=2,88$  ) ;  $IIT = 0.5374$  ;
- VIIT equation:  $\ln RCA = 0.8207$  (  $RCA=2,72$  ) ;  $VIIT = 0.49276$  ;
- HIIT equation:  $\ln RCA = 0.26777$  (  $RCA = 1.307$  ) ;  $HIIT = 0,6038$ .

TABLE 1 – Regression results for bilateral IIT, VIIT and HIIT (product level)

Dependent variable	Constant	lnRCA	(lnRCA) <sup>2</sup>	R <sup>2</sup>	DW	n
ln IIT	-1,264 (-19,3)	0,429* (6,972)		0,109	1,965	398
ln IIT	-0,947 (-24,7)	0,62* (17,57)	-0,293* (-29,16)	0,718	2,01	398
ln VIIT	-1,319 (-15,9)	0,567* (7,43)		0,178	1,952	258
ln VIIT	-0,931 (-20,18)	0,545* (13,5)	-0,332* (-25,67)	0,771	2,12	258
ln HIIT	-1,126 (-13,6)	0,631* (6,298)		0,221	1,873	142
ln HIIT	-0,561 (-15,0)	0,422* (10,79)	-0,788* (-28,58)	0,887	2,25	142

The figures in parentheses are t-values. The symbol \* denotes that the coefficient is significant at the 1 per cent confidence level. The values of Durbin-Watson test (DW) indicate that there is no auto-correlation.

## V. Main conclusions

A priori we expected that RCA would explain the variation of the VIIT and that the correlation would be positive. The results confirm that prediction. But the results give us another unexpected result: the differences of relative autarchy costs between countries (proxy by the RCA differences) have a positive effect on HIIT and on total IIT. Furthermore, we have an inverted-U relationship between all types of IIT and RCA. As we used only a simple model, we must be careful with the conclusions. But, there is some empirical evidence against the prediction made by theory for separating the determinants of horizontal and vertical IIT.

As we pointed out in the introduction, we used to consider that HIIT fell much more within the field of modern theories of trade. According to the theory, HIIT is explained by the interaction between economies of scale and (horizontal) product differentiation. VIIT can be explained by comparative advantages in the context of Heckscher –Ohlin (H-O) or Ricardo- Heckscher-Ohlin (R-H-O) framework, without recourse to economies of scale.

Following Tharakan and Kerstens (1995, p.87), “The latter study [Tharakan,1989] which carries out a product-by-product analysis (corresponding to SITC 5-digit ) suggests that the observed IIT is partly due to H-O-type determinants and partly caused by other factors such as vertical, and in some cases, horizontal product differentiation.” In the same way of the rising importance of traditional trade theories, especially the Ricardo model and H-O-Vanek factor content model, we can refer to the theoretical and empirical studies of Davis (1995), Davis and Weinstein (1996, 2000) and Davis et al. (1996, 1997).

In synthesis, is not easy and may not be correct to separate the components of this “untidy” phenomenon: the intra-industry trade.

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