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INTRA-INDUSTRY TRADE IN THE AUTOMOBILE SECTOR: THE PORTUGESE EXPERIENCE

This study examines the determinants of intra-industry trade (IIT), horizontal IIT (HIIT) and vertical IIT (VIIT) in the automobile industry in Portugal. The trade in this sector between Portugal and the European Union (EU-27) was examined, between 1995 and 2008. These results indicate that intra-industry trade occurs more frequently among countries that are similar in terms of factor endowments. The findings support the theory that, in general, there is no positive statistical association between HIIT and Heckscher-Ohlin variables. We also introduce the economic dimension, and common border; these proxies confirm the positive effects in bilateral trade. Our results also confirm the hypothesis that trade increases if transportation costs decrease.

Keywords: horizontal intra-industry trade, vertical intra-industry trade, Portugal, automobile industry

JEL Classification: C20, F12, F14

INTRODUCTION

In recent years, the automobile sector has become a topical issue in the empirical trade literature. Globalization has given rise to a new paradigm in international economics, i.e. the fragmentation theory (see Jones and Kierzkowski, 1990). The trade in the automobile sector between different units of multinational corporations is a good example of the fragmentation of the production and of the emergence of IIT through multinational firms.

This paper tests the determinants of intra-industry trade (IIT), horizontal (HIIT) and vertical intra-industry trade (VIIT) in the automobile sector. We examine the trade in this sector between Portugal and the European Union (EU-27). The period 1995-2008 was chosen on the basis of its providing a sufficient number of observations. The methodology uses a panel data approach. The panel is unbalanced due to the lack of information on some countries in all of the years analyzed.

The studies of intra-industry trade can be classified into two areas. The first category is based on theoretical models (see for example, Krugman,

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1979; Lancaster, 1980; Helpman, 1981; Brander and Krugman, 1983; Eaton and Kierzkowski, 1984, Falvey 981; Falvey and Kierzkowski, 1987, Shaked and Sutton 1984, Flam and Helpman 1987). The second category explains the determinants of intra-industry trade (see Tharakan and Kerstens, 1995; Sharma, 2002; Kimura et al., 2007; Clark, 2006).

The results presented in this paper for this specific industrial sector are generally consistent with the expectations of intra-industry trade studies. The remainder of the paper is organized as follows: Section 1 presents the theoretical background; Section 2 presents the indexes of intra-industry trade used in this study. Section 3 displays the econometric model; Section 4 presents the estimation results; and the final section provides the conclusions.

1. LITERATURE REVIEW

The traditional trade theories are based on constant returns to scale, homogenous product and perfect competition (Ricardian and Heckscher-Ohlin trade theory). These theories could explain inter-industry trade based on comparative advantages. The pioneering works on IIT (Krugman, 1979; Lancaster, 1980; Helpman, 1987) exclude the idea that traditional theories could explain IIT.

The models of IIT (Krugman, 1979; Lancaster, 1980; Helpman, 1987; Brander and Krugman, 1983; Eaton and Kierzkowski, 1984) are based on monopolistic competition and increasing returns. The neo-Chamberlinian models, such as the 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 these models, each variety is produced under decreasing costs and when the countries engage in trading, the similarity of the demands leads to intra-industry trade. This hypothesis of similarity of demands to explain trade between similar countries was first considered by Linder (1961).

When product differentiation is considered, we have two types of differentiation and different models of IIT. Horizontal differentiation, or differentiation by attributes other than quality, gives rise to the horizontal IIT models, whereas vertical differentiation – differentiation by quality – originates the vertical IIT models. These models have different underlying determinants (Greenaway et al., 1994, 1995). Vertical IIT can be explained by traditional trade theories (see Davis, 1995). Falvey (1981), Falvey and Kierzkowski (1987), Shaked and Sutton (1984) and Flam and Helpman

(1987) introduced the vertical differentiation models. The vertical IIT indexes are also used to measure the fragmentation of the production.

Horizontal differentiation is more likely between countries with similar factor endowments and horizontal IIT cannot be explained by traditional trade theories. The pioneering Krugman models consider that the products are horizontally differentiated. Brander and Krugman (1983) used a Cournot formulation to explain the intra-industry trade. The authors demonstrated that it is possible to explain IIT by reciprocal dumping.

As IIT encompasses both vertical IIT and horizontal IIT, we can test if the factors that explain comparative advantages, differences in relative factor endowments also explain IIT.

2. GRUBEL AND LLOYD INDEXES

Grubel and Lloyd (1975) define IIT as the difference between the trade balance of industry *i* and the total trade of this same industry. In order to make comparisons easier between industries or countries, the index is presented as a ratio, where the denominator is total trade.

$$IIT_{it} = 1 - \frac{\left|X_i - M_i\right|}{\left(X_i + M_i\right)} \Leftrightarrow IIT_{it} = \frac{\left(X_i + M_i\right) - \left|X_i - M_i\right|}{\left(X_i + M_i\right)} \quad (1)$$

where X_i and M_i are export and import to partner country *i*.

The index is equal to 1 if all trade is intra-industry. If IIT_{it} is equal to 0, all trade is inter-industry trade.

Grubel and Lloyd (1975: 22) proposed an adjustment measure to the country IIT index (IIT calculated for all individual industries), introducing the aggregate trade imbalance.

Aquino (1978: 280) also considered that an adjustment measure is required, but to a more disaggregated level, but for this, the Grubel and Lloyd method is inadequate. Following Aquino, we require an appropriate imbalance effect. The imbalancing effect must be equi-proportional in all industries. So, the Aquino measure at the 5-digit level estimates "what the values of exports and imports of each commodity would have been if total exports had been equal to total imports".

2.1. HIIT and VIIT Indexes

To determine the horizontal and vertical intra-industry trade, Grubel and Lloyd indexes and the methodology of Abd-el-Rahaman (1991) and

Greenaway et al. (1994) are used.

$$HIIT_{it} = \frac{RH}{\left(X_i + M_i\right)} \tag{2}$$

HIIT – horizontal intra-industry trade index;

RH – total horizontal intra-industry trade;

TT_{ij} – relative unit values[1] of exports and imports are used to disentangle HIIT and VIIT.

If $TT_{ij} \in [0.85;1.15]$, we have horizontal IIT.

$$VIIT_{it} = \frac{RV}{\left(X_i + M_i\right)} \tag{3}$$

VIIT – vertical intra-industry trade index;

RV – total vertical intra-industry trade.

If $TT_{ij} < 0.85$ V $TT_{ij} > 1.15$, we have vertical IIT. When $TT_{ij} < 0.85$, we have inferior VIIT (lower quality). When $TT_{ij} > 1.15$, we have superior VIIT (higher quality).

3. ECONOMETRIC MODEL

The dependent variable used is the IIT Grubel and Lloyd (1975) index, HIIT and VIIT indexes at five-digit level of the Standard International Trade Classification (SITC). The explanatory variables are country-specific characteristics. The data sources for the explanatory variables are the World Bank Development Indicators (2010). The source used for the dependent variable was data from INE, the Portuguese National Institute of Statistics.

3.1. Hypotheses and definition of explanatory variables

Hypothesis 1: There is a negative (positive) correlation between differences in per-capita income and IIT and HIIT (VIIT).

LogDGDP is the logarithm of absolute difference in per-capita GDP (PPP, in current international dollars) between Portugal and the trading

[1] $TT = \frac{P_{it}^X}{P_{it}^M}$ where P_{it}^X and P_{it}^M are unit prices of exports and imports.

partner. Loertscher and Wolter (1980) suggested a negative sign for the IIT model. The hypothesis 1 was formulated based the Linder (1961) theory. Linder (1961) considers that countries with similar demands have similar products. So, the Linder hypothesis suggests a negative sign for the IIT model (Helpman,1987; Hummels and Levinsohn, 1995).

Regarding the hypothesis 1, Loertscher and Wolter (1980) and Balassa (1986) estimated a negative coefficient. The recent study of Ferto and Soós (2008) also found a negative sign. The model of Falvey and Kierzkowski (1987) suggest a positive impact between income difference and VIIT. The empirical works of Loertscher and Wolter (1980) and Greenaway et al. (1994) provide empirical support for a negative relation between difference in per-capita income and HIIT.

Hypothesis 2: IIT and HIIT occur more frequently among countries that are similar in terms of factor endowments.

LogEP is a proxy for differences in physical endowments. It is the logarithm of the absolute difference in electric power consumption (Kwh per capita) between Portugal and its partners. Considering hypothesis 2, the model of Helpman and Krugman (1985), Hummels and Levishon (1995) suggest a negative effect of physical endowment on IIT. Zhan et al. (2005) use the absolute difference in electric power consumption in examining IIT for China. Zhang et al. (2005) found a negative sign to IIT and a positive sign to VIIT.

Hypothesis 3: The economic dimension influences the volume of trade positively.

LogDIM is the logarithm of the average GDP of the two trading partners. Usually the studies utilized this proxy to evaluate the potential economies of scales and the variety of differentiated product. A positive sign is expected for the coefficient of this variable (see, for example, Greenaway et al., 1994, Hummels and Levinshon, 1995).

Hypothesis 4: Trade increases when partners are geographically close.

LogDISTxEP is the logarithm of geographical distance between Portugal and the partner country multiplied by electric power. Following the most empirical studies, we used kilometres between the capital cities of the trading partners. According to the literature, we expect a negative sign (Badinger and Breuss, 2008, Blanes 2006, and Cieslik, 2005).

Border x *DGDP* is a dummy variable that assumes the value 1 when the

trading partner of Portugal is Spain and zero otherwise, multiplied by difference in per-capita GDP.

A common border implies lower transports costs, i.e. reduction of trade barriers. Chemsripong et al. (2005) applied a similar approach for Thailand and APEC countries. Papazolou et al. (2006), and Faustino and Leitão (2008) also found a positive sign.

3.2. Model Specification

$$IIT_{it} = \beta_0 + \beta_1 X_{it} + \delta t + \eta_i + \varepsilon_{it} \quad (4)$$

Where IIT_{it} stands for either IIT, HIIT, or VIIT, meaning total, vertical or horizontal Portuguese IIT index and X is a set of explanatory variables. All variables are in the logarithm form; η_i is the unobserved time-invariant specific effect; δt captures a common deterministic trend; ε_{it} is a random disturbance assumed to be normal, and identically distributed with E (ε_{it})=0; Var (ε_{it}) = $\sigma^2 \succ 0$.

Following the empirical work of Hummles and Levinsohn (1995), we apply a logistic transformation to IIT, HIIT and VIIT because these indexes vary between zero and one. LOGISTIC IIT = ln [(IIT/(1-IIT)]. The same transformation is made for HIIT and VIIT.

4. ESTIMATION RESULTS

In this section we present the results with country characteristics as explanatory variables.

The panel data models we estimated with Pooled OLS, fixed effects and random effects (RE) estimators. The F statistics tests the null hypothesis of the same specific effects for all countries. The Hausman test can decide which model is better: random effects (RE) versus fixed effects (FE).

In Table 1, we can observe the country-specific determinants of intra-industry trade in the automobile sector, together with the estimated coefficients estimator. The general performance of the model is satisfactory (Adjusted $R^2 = 0.53$). The Hausman test rejects the null hypothesis random effects versus fixed effects. In our case, the random effects estimator was excluded because our sample is not random.

Table 1

Determinants of Intra-Industry Trade

Variables	Fixed Effects	*t-statistics*	Significance	Expected Sign
LogDGDP	(-1.380)	(-3.032)	***	(-)
LogEP	(2.549)	(2.114)	**	(-)
LogDIM	(1.003)	(1.165)		(+)
LogDISTxEP	(-0.900)	(-5.724)	***	(-)
Adj. R^2	0.53			
Hausman test of H0:RE vs. FE Asymptotic test statistics: Chi-square(4) = 49.993, P-value = 0.001 F(24,296) = 10.053, P-value =0.000				
Observations	330			

T-statistics (heteroskedasticity corrected) are in round brackets.

Note: ***/** /* – statistically significant, respectively at the 1%, and 5%, levels

Source: The estimates presented were produced by the author.

All explanatory variables are significant (LogDGDP at 1%, LogEP at 5%, LogDISTxEP at 1% level) with the exception of LogDIM. The difference between per-capita incomes, in logs, (LogDGDP) presents a negative sign. However, the negative estimated sign was expected. According to Linder (1961) we can conclude that countries with similar demands trade similar products.

Following Falvey and Kierzkowski (1987), we introduced one proxy for the difference in factor endowments (electric power). The variable, electric power in logs (LogEP) presents a positive sign. This result was not expected by Hummels and Levinsohn (1995). The solution could be to use capital/labour ratios. Unfortunately, this data is not freely available.

The geographical distance (LogDISTxEP) has been used as a typical gravity model variable. A negative effect of the distance on bilateral IIT was expected and the results confirm this, underlining the importance of neighbour partnerships for all trade.

Table 2 presents the results using the horizontal intra-industry trade equation. The absolute difference in electric power consumption (LogEP) is statistically significant, with an expected negative sign. This result is according to previous studies (Hummels and Levishon, 1995; Zhang et al. 2005). We can conclude that countries have similar factor endowments.

Table 2

Determinants of Horizontal Intra-Industry Trade

Variables	Fixed Effects	*t-statistics*	Significance	Expected Sign
LogDGDP	(-0.2973)	(-0.202)		(-)
LogEP	(-6.756)	(-2.598)	**	(-)
LogDIM	(15.994)	(5.413)	***	(+)
LogDISTxEP	(-2.781)	(-3.558)	***	(+)
Adj. R^2	0.49			
Hausman test of H0:RE vs. FE Asymptotic test statistics: Chi-square(3) =25.420 P-value = 0.000 F(24,157) = 5.897, P-value =0.000				
Observations	189			

T-statistics (heteroskedasticity corrected) are in round brackets.

Note: ***/** /* – statistically significant, respectively at the 1%, 5%, and 10% levels.

Source: The estimates presented were produced by the author.

As expected, the variable LogDIM (average per capita GDP) between Portugal and the considered partner) has a significant and positive effect on trade. Therefore, the intensity of HIIT is positively correlated with the similarity in per capita income between trading partners.

The coefficient of LogDISTxEP (geographical distance multiplied by electric power) is negative as expected. The studies of Balassa and Bauwens (1987), Badinger and Breuss, (2008), Blanes (2006), Cieslik (2005), Bergstrand and Egger (2006) also found a negative sign.

Vertical intra-industry trade estimates are reported in Table 3, using a Fixed Effects estimator. The hypothesis for economic differences between countries (DGDP) in logs presents a positive sign and is significant at a 1% level. Falvey and Kierzkowski (1987) suggest a positive effect of income difference on VIIT model and Kimura et al. (2007) and Wakasugi (2007) found a positive relationship between income difference and VIIT for parts and components trade while Egger and Egger (2005) found a negative relationship for EU processing trade. We can conclude that VIIT occurs more frequently among economies that are dissimilar, i.e differentiation by quality of products.

Table 3

Determinants of Vertical Intra-Industry Trade

Variables	Fixed Effects	*t-statistics*	Significance	Expected Sign
LogDGDP	(0.455)	(2.678)	***	(+)
LogEP	(0.425)	(3.062)	***	(+)
LogDIM	(0.515)	(1.636)		(+)
BORDERxDGDP	(0.202)	(2.213)	**	(+)
Adj. R^2	0.36			
Hausman test of H0:RE vs. FE Asymptotic test statistics: Chi-square(4) =12.420 P-value = 0.0170 F(24,283) = 5.515, P-value =0.000				
Observations	317			

T-statistics (heteroskedasticity corrected) are in round brackets.

Note: ***/** /* – statistically significant, respectively at the 1%, and 5%, levels.

Source: The estimates presented were produced by the author.

The coefficients electric power consumption (EP) and the BorderxDGDP (common border multiplied by differences in per-capita income) are consistent with the expected sign. We expect the difference in electric power consumption per capita to reflect the difference in endowments between Portugal and its trade partners, following the approach by Hummels and Levinshon (1995) and Zhan et al. (2005). Regarding the hypothesis for the effect of Border on VIIT, our empirical results do support that VIIT is more frequent between countries with a similar cultural background, namely Portugal and Spain.

CONCLUSION

The objective of this paper was to analyze the determinants of intra-industry trade in automobile sector.

The variable (LogDGDP) used to evaluate the relative factor endowments presents a negative impact on IIT. This result is according to the literature (Loertscher and Wolter, 1980). The study of Zhang and Clark (2009) also found a negative sign to the U.S. experience. IIT occurs more frequently among countries that are similar in terms of factor endowment.

We find a positive correlation between LogDGDP and vertical IIT. Our results show that the higher the difference in GDP per capita between Portugal and trade partner, the higher will be VIIT.

As regards the variable differences in physical capital endowments (LogEP), our results validate the hypothesis: HIIT occurs more frequently among countries that are similar in terms of factor endowments. With regard to VIIT, our paper finds a positive effect of difference in electric power consumption.

According to the literature we expected a negative sign to geographical distance. It is usual that the literature attributes a negative sign to geographical distance, i.e. trade increases if the partners are geographically close. The findings support this hypothesis.

The variable common border confirms the theoretical models; i.e. a common border promotes trade inflows.

In the future, we need to improve research on cultural variables as in Portuguese colonies, and historical proxies.

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