

INTRA-INDUSTRY TRADE IN THE AUTOMOBILE COMPONENTS INDUSTRY: AN EMPIRICAL ANALYSIS

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ABSTRACT

This manuscript examines the determinants of intra-industry trade (IIT) in the automobile component sector in Portugal. We have examined the Portuguese trade in this sector between European Union (EU-27), the BRIC (Brazil, Russia, India and China), and United States between 1995 and 2006. Using a panel data approach, the results show a negative correlation between endowments and IIT. These results indicate that IIT occurs more frequently among countries that are similar in terms of factor endowments. We also introduce economic and cultural dimensions; these proxies confirm the positive effects of IIT. Our results also confirm the hypothesis that trade increases if the transportation costs decrease.

INTRODUCTION

In the end of 70's, emerged "new trade theories". These models as in Krugman (1979), Lancaster (1980), Helpman (1981), Eaton and Kierzkowski (1984) and Helpman and Krugman (1985) introduced a new reality: intra-industry trade (IIT). For others words, these models permit to explain the simultaneous trading (export and import) of a product within a particularly industry. All these models consider the imperfect competition, and economies of scales, and product differentiation.

The empirical models in mid of 80's and the beginning 90's permits introduced two type of products differentiation (horizontal and vertical intra-industry trade). Greenaway et al. (1994, 1995), and Abd-El-Rahaman (1991) proposed this idea in empirical work.

Horizontal intra-industry trade (HIIT) refers that type of trade occurs within similar quality products. The products are differentiated by attributes (see Krugman, 1979, Lancaster, 1980, Eaton and Kierzkowski 1984, and Helpman and Krugman (1985). Vertical intra-industry trade (VIIT) is explained by different varieties of quality products (see Falvey, 1981, Falvey and Kierzkowski 1987, and Shaked and Sutton, 1984). For example, if the home country is capital abundant, this country will produce a higher quality of products,

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when we compare with a foreign country (labor abundant). These types of trade are explained by price and quality. In this paper, we analyze the country-specific determinants of intra-industry trade in Portugal in the automobile parts and components industry between European Union 27 (EU-27), of the BRICS countries (Brazil, India, Russia, and China) and United States (US), using an unbalanced panel data for the period 1995-2006. In this paper we seek to test some hypothesis suggested by the theory of monopolistic competition and the Neo-Heckscher - Ohlin theory.

Most previous studies examine intra-industry trade (IIT) covering the industries or countries (Greenaway et al. 1994, 1995, Hummels and Levinsohn, 1995, Aquino, 1978, Balassa, 1986). Only a few empirical studies analyze one industry-specific of intra-industry trade (Tharakan and Kerstens, 1995, Aturupane et al. 1999, Sharma, 2002, Umemoto, 2005, Kimura et al., 2007, Clark 2006, and Wakasugi 2007). With globalisation, we assist a new paradigm in international economics, i.e. fragmentation, or outsourcing. The trade in automobile components between different units of multinational corporations is a good example of this type of trade.

Until the 60's there were not yet the empirical studies that evaluate this phenomenon. In 1970's, internalization and free mobility of capital across multinational corporations began empirical studies on intra-industry trade (Grubel and Lloyd, 1975). But it is in 90's that international economics research studies this topic (Jones and Kierzkowski, 1990). In this paper, we revisit Umemoto's (2005) empirical test as well as the empirical studies of Montout et al. (2002) and , Kimura et al., 2007, Clark 2006, and Wakasugi 2007. Umemoto (2005) analyzed the intra-industry trade between Japan and Korea. The study of Umemoto (2005) shows that VIIT is higher than HIIT in automobile component sector. Montout et al. (2002) consider the determinants of IIT for the automobile sector and automobile components in NAFTA. The authors consider the horizontal intra industry-trade (HIIT), and vertical intra-industry trade (VIIT) as dependent variable using country and industry specific characteristics. Kimura et al. (2007) analyzed parts and components trade between East Asia and Europe. This study also shows that VIIT is higher than HIIT. The study of Clark (2006) also demonstrated the importance of automobile components. Wakasagi (2007) utilized a gravity model to explain the trade between East Asian and NAFTA and European Union.

In static panel data, pooled OLS, fixed-effects (FE) and random-effects (RE) estimators are used in this type of study. The RE estimator was excluded because our sample is not random. Furthermore, the Hausman test rejects the null hypothesis RE versus FE. We decided against using the fixed-effects estimator, as some relevant variables do not vary along time. Therefore, the regression coefficients are estimated using OLS with time dummies, and TOBIT model (see Clark, 2006). We also decided to introduce a dynamic panel data. The estimator used (GMM-SYS) permits researchers to solve the problems of serial correlation, heteroskedasticity and endogeneity of some explanatory variables. These econometric problems were resolved by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998, 2000), who developed the first-differenced GMM estimator (GMM-DIF) and GMM system estimator (GMM-SYS). To estimate the dynamic models, we applied the methodology of Blundell and Bond (1998, 2000). The results presented in this paper are generally consistent with the predictions of intra-industry trade studies. The remainder of the paper is organized as follows: section 2 presents the theoretical background; section 3 presents the econometrical model; section 4 shows the estimation results; the final section provides conclusions.

LITERATURE REVIEW

In this section we present a survey of theoretical models of intra-industry trade (IIT). The pioneering models of IIT exclude the idea that the traditional theories of trade (Ricardian trade theory and Heckscher-Ohlin trade theory) could explain *two-way trade*. With Falvey (1981), Falvey and Kierzkowski (1987), Shaked and Sutton, (1984), Flam and Helpman (1987), and Davis (1995) emerged a news models of IIT explained with traditional theories.

The models of HIIT (Krugman (1979), Lancaster, (1980), Helpman (1981), Brander and Krugman, (1983), and Eaton and Kierzkowski, (1984) are based on assumptions of monopolistic competition, and increasing returns to scale. The model of Krugman (1979) is an example of Neo-Chamberlinian models (Dixit and Norman 1980, and Venables 1984), as also called “love for variety approach”. Kurgman’s model considers that consumers have the same utility function. The intra-industry trade occurred in long run, when two identical economies (geographical proximity) build an integrate market. Lancaster (1980), Helpman (1981) developed a Neo-Hotelling model “ideal variety approach”. With Neo- Hotelling model, the consumer has an ideal of product, a map of preferences. Brander and Krugman (1983) explain the intra-industry in identical commodities using a Cournot formulation. In this model, the authors demonstrate that it is possible to occur IIT with reciprocal dumping. These models analyze the IIT according to the similarity of demands. HIIT is more likely between countries with similar factor endowments. The traditional trade theories (Smith, Ricardo, and Heckscher-Ohlin) cannot be explained by HIIT.

The models of VIIT (Falvey, 1981, Falvey and Kierzkowski, 1987, Shaked and Sutton, 1984, and Flam and Helpman, 1987) are explained by HO model, price- income and quality of products. These models consider that consumers rank alternative varieties.

In the vertical differentiation, different varieties are of different qualities. The demand side, we have consumers with different preferences, i.e., there is a correlation between quality and price. On supply side, it is assumed that varieties could be higher or low- quality. The lower quality products will be labor intensive and the higher quality will be capital intensive.

The countries labor abundant have comparative advantages in low- quality (labor intensive), and the countries capital abundant will be comparative advantages in higher-qualities. Falvey and Kierzkowski (1987) followed Linder (1961) theory. The authors consider that vertical differentiation could be explained by differences between per capita incomes. Falvey and Kierzkowski (1987) concluded that countries are capital-abundant have higher productivity and higher wages. Symmetrically, the labor abundant country (low-wage country) will have comparative advantages in low-quality varieties that are labor-intensive. Flam and Helpman (1987) contains the differences in technology (labor productivity) that explain VIIT. The country with most productivity has higher wages and exports the higher-quality products.

In the Shaked and Sutton’s article (1984), trade is studied in the context of a natural oligopoly, vertical product differentiation. The IIT is explained by different varieties of quality products (differences in income distribution: lower income country specializing in lower quality products, higher income specializing of quality products). Davis (1995) explains IIT with constant returns to scale and comparative advantages associated with perfect competition. Davis developed the model considering that Ricardian and Heckscher-Ohlin influence the IIT and inter-industry trade (based in comparative advantages).

MEASUREMENT OF INTRA-INDUSTRY

Grubel and Lloyd (1975) define IIT as the difference between the trade balance of industry 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.

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

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 imbalance effect must be equi- proportional in all industries. So, the Aquino 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.

Econometric Model

Following the literature our study applies a gravity equation with panel data. The dependent variable used is intra-industry trade (*IIT*) in automobile components. It is calculated with the disaggregation of five digits CAE (Economic Activities Classification) of the automobile components. The data for the explanatory variables is sourced from the World Bank, World Development Indicators (2008). The source used for the dependent variable was INE – the Portuguese National Institute of Statistics.

Explanatory Variables

Hypothesis 1: There is a negative relationship between differences in per-capita income and IIT

LogDGDP is the logarithm of absolute difference in per-capita GDP (PPP, in current international dollars) between Portugal and the trading partner. Loertscher and Wolter (1980) suggest a negative sign for the IIT model.

Unemoto (2005) found a negative, when analysed the determinants of automotive parts between Korean and Japan. Also the study of Montout et al. (2002) found a negative sign, when he examined the determinants of IIT for the automobile industry and parts and components in NAFTA.

Following the study of Matthews (1998) applied to Australia, we decided to consider the following proxy: EUxDGDP is a multiplicative dummy variable that equals 1 if European trade partner and 0 otherwise. A negative sign is expected.

Hypothesis 2: IIT occurs more frequently among countries that are similar in terms of factor endowments

LogEP is a proxy for differences in physical capital endowments. It is the logarithm of the absolute difference in electric power consumption (Kwh per capita) between Portugal and its partners. Based on Helpman and Krugman (1985), Hummles and Levinshon (1995) we expected a positive sign for the coefficient of this explanatory variable.

EUxEP is a multiplicative dummy variable that equals 1 if European trade partner and 0 otherwise. The study of Matthews (1998) also considers this type of variable.

Hypothesis 3: The economic and culture dimension influences the volume of trade

LogDIM is the logarithm of 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. Umemoto (2005) found a positive sign.

Following the study of Chemsripong, et al. (2005) applied to Thailand and APEC countries, we decided the following proxy: US is a dummy variable that equals 1 if the US is the partner- country shares, and 0 otherwise. The expected sign is positive. This variable analyses the culture strategy between Portugal and United States. US accepted many Portuguese immigrants. Portugal and US have cooperation agreements. So

these two partners have excellent diplomatic and military relations.

Hypothesis 4: Trade increases when partners are geographically close

LogDIST is the logarithm of geographical distance between the Portugal and partner country. Following the major empirical studies, we use Kilometres between the capital cities of trading partners. This proxy is usually used as transport cost, or market access barriers. According to the literature we expected a negative sign (Badinger and Breuss, 2008, Blanes 2006, and Umemoto, 2005).

Model Specification

$$IIT_{it} = \beta_0 + \beta_1 X_{it} + \delta t + \eta_i + \varepsilon_{it}$$

Where IIT_{it} is the Portuguese IIT index, X is a set of explanatory variables. All variables are in the logarithm form; η_{it} is the unobserved time-invariant specific effects; δt captures a common deterministic trend; ε_{it} is a random disturbance assumed to be normal, and identical distributed (IID) with $E(\varepsilon_{it})=0$; $Var(\varepsilon_{it})=\sigma^2 > 0$.

The model can be rewritten in the following dynamic representation:

$$IIT_{it} = \rho IIT_{it-1} + \beta_1 X_{it} - \rho \beta_1 X_{it-1} + \delta t + \eta_i + \varepsilon_{it}$$

Following the empirical work of Hummles and Levinsohn (1995) we applied a logistic transformation to IIT, because IIT is an index varying between zero and one:

$$IIT_{it} = \text{Ln} [IIT_{it}/(1-IIT_{it})]$$

EMPIRICAL STUDY

In this section we present the results with country characteristics as explanatory variables. We include in this estimation the European countries (EU-27), BRIC'S (Brazil, Russia, India, and China), and the United States in our model.

In table 1 we present OLS estimator with time dummies. Our analysis pretends to evaluate the signs of the coefficients and their significances.

This equation was introduced as an explanatory variable of IIT in parts and components. The differences between per capita incomes, in logs, (LogDGDP), the difference in electric consumption (LogEP) in Kwh per capita, economic dimension (LogDIM), the geographical distance, the impact of United States (US, this a dummy variable, this proxy permits to consider the cultural dimension, i.e. the cultural and historical relationships between Portugal and US), EUxDGDP (is a multiplicative dummy variable, that permits to evaluate the impact of European countries by differences of incomes per capita), and other multiplicative dummy variables (EUxEP) analyze the correlations between European countries and electric consumption per capita.

The model presents six statically significant variables: (LogDGDP, at 5%), electric power consumption (LogEP, at 10%), the geography distance (LogDIST, at 1%), cultural dimension (US, at 10%),

and the variable EUxDGDP (at 5%), and EUxEP (at 10%) validate the hypotheses formulated. The absolute difference in per capita incomes in logs (LogDGDP) presents a positive sign and is significant at 5% level. This result, according to Chemsripong et al. (2005), presents the larger gap of per capita income between trading partners, the larger the level of inequality in development. As Portuguese IIT is mainly vertical intra-industry trade (VIIT), this is consistent with the neo-Heckscher-Olin trade theory.

Table 1: The determinants of intra-industry trade: OLS estimator with time dummies

Variables	OLS	<i>t</i> -statistics	Significance	Expected Sign
LogDGDP	12.101	(2.07)	**	(-)
LogEP	-12.165	(-1.74)	*	(-)
LogDIM	3.507	-1.47		(+)
LogDIST	-4.008	(-6.33)	***	(-)
US	6.21	(1.91)	*	(+)
EUxDGDP	-12.047	(-2.05)	**	(-)
EUxEP	13.999	(1.99)	*	(-)
C	-7.563	(-0.756)		
N	210			
$\overline{R^2}$	0.25			

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

***/**/*- statistically significant, at 1%, 5%, and 10% levels.

We incorporate the difference in electric power consumption per capita, to analyse the difference in endowments between Portugal and its trade partners. As in Hummles and Levinshon (1995), Zhan et al. (2005) we expected a negative, and we have a correct sign. The geographical distance is according to the literature: a negative relationship between the share of total Intra-industry trade (IIT) and distance is expected. The cultural dimension (US) confirms the idea that the United States is an important cultural partner for Portugal. This proxy analyzes the culture strategy between Portugal and United States. US had accepted many Portuguese immigrants, and these two countries have excellent diplomatic and military relations.

For the proxy EUxDGDP and EUx EP, we expected a negative to total IIT, and we have these results. We can conclude that total IIT occurs more frequently among countries that are similar in terms of factor endowments.

In table 2, we can observe the determinants of intra-industry trade using PROBIT model.

Table 2: The determinants of intra-industry trade: PROBIT estimator

Variables	PROBIT	<i>t</i> -statistics	Significance	Expected Sign
LogDGDP	9.901	(2.134)	**	(-)
LogEP	-10.184	(-1.856)	*	(-)
LogDIM	3.629	(2.888)	***	(+)
LogDIST	-4.117	(-3.837)	***	(-)
US	5.071	(1.982)	*	(+)
EUxDGDP	-9.829	(-2.12)	**	(-)
EUxEP	11.304	(2.049)	**	(-)
C	-6.075	(-0.830)		
N	201			
LR		62.208	***	

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

***/**/*- statistically significant, at 1%, 5%, and 10% levels.

All explanatory variables are significant: (LogDGDP, at 5%, LogEP, at 10%, LogDIM, at 1%, LogDIST, at 1%, US at 10%, EUxDGDP, and EUxEP, at 5%). The difference between per capita incomes, (LogDGDP) presents a positive sign, this results is contradictory of the hypothesis formulated. The variable, electric power (LogEP) presents a negative sign, confirming the dominant paradigm. We can conclude that the

probability of economic and cultural dimension (DIM, US) to influence positively total IIT is confirmed. As in Chemsripong et al. (2005) culture dimension is positively related to IIT.

The geographical distance presents a negative correlation confirming the results of Badinger and Breuss (2008), Clark (2006), Chemsripong et al. (2005). For the difference between in factor endowments, the literature refers a negative sign. The proxy EUxDGDP confirmed this, but the coefficient of EUxEP presents a contradictory sign.

As table 3 shows, the equation presents consistent estimates, with no serial correlation (m1, m2 statistics). The specification Sargan tests show that there are no problems with the validity of instruments used for both equations. The instruments in levels used are: LogIIT_{it} (2,7), Log EP (2,7), LogDIM (2,7), for first differences. For levels equations, the instruments used are first differences of all variables lagged t-1.

The model presents eight significant variables (IIT_{t-1}, LogDGDP, LogEP, LogDIM, LogDIST, US, EUxDGDP, and EUxEP). As expected, the lagged dependent variable is positive.

The variable LogDGDP presents a positive sign and is significant at 1% level. This result was not expected. The variable, electric power in logs (LogEP) presents a negative sign, confirming the theoretical forecast proposed by the literature. Zhan et al. (2005) found a negative sign.

Table 3 – The determinants of intra-industry trade: GMM-SYS estimator

Variables	GMM-System	t-statistics	Significance	Expected Sign
IIT _{t-1}	0.189	(2.78)	***	(+)
LogDGDP	21.148	(2.79)	***	(-)
LogEP	-24.189	(-2.75)	***	(-)
LogDIM	7.379	(3.11)	***	(+)
LogDIST	-3.013	(-2.25)	**	(-)
US	11.921	(3.43)	***	(+)
EUxDGDP	-21.364	(-2.86)	***	(-)
EUxEP	25.246	(2.81)	***	(-)
C	-25.895	(-2.57)	***	
M1	0.9411	[0.347]		
M2	0.3627	[0.717]		
W _{JS} , df=8	10.34	[0.242]		
Sargan, df=172	5.782	[1.000]		
N	177			

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

***/**/*- statistically significant, at 1%, 5%, and 10% levels.

The null hypothesis that each coefficient is equal to zero is tested using one-step robust standard error. T-statistics (heteroskedasticity corrected) are in round brackets. ***, **, and * indicates statistically significance, respectively at the 1%, and 5% level. P-values are in square brackets. Year dummies are included in all specifications (this is equivalent to transforming the variables into deviations from time means, i.e. the mean across the fourteen countries for each period). M1 and M2 are tests for first-order and second-order serial correlation in the first-differenced residuals, asymptotically distributed as N (0, 1) under the null hypothesis of no serial correlation (based on the efficient two-step GMM estimator). W_{JS} is the Wald statistic of joint significance of independent variables (for first-steps, excluding time dummies and the constant term). Sargan is a test of the over-identifying restrictions, asymptotically distributed as χ^2 under the null of instruments' validity (with two-step estimator).

The variable, LogDIM (average of GDP), used also by Greenaway, et al. (1994), has a significant and predicted positive effect on IIT. A study of Hellvin (1996) analyses the case of China also found a positive sign to market size, or economic dimension. The proxy geographic distance (LogDIST) is typically used as a proxy for transport costs. We find a negative sign, parallel to the literature. Chemsripong, et al. (2005) analyzed the

determinants of IIT to Thailand, and also found a negative sign. As expected the dummy variable US is positive with high level significant, this validates our hypotheses, i.e. the importance of culture dimension on trade.

EUx DGDP has been used as a typical gravity model variable. A negative effect of difference incomes per capita on bilateral intra-industry trade was expected and the results are in conformity. For the difference between in factor endowments, the literature attributes a negative sign, and the coefficient (EUxEP) presents a contradictory sign.

CONCLUSIONS

The objective of this study was to analyze some of the determinants of intra-industry trade in automobile components sector. Comparing our findings with other empirical studies, we obtained similar results. Econometric estimations support the hypothesis formulated. Our results are robust with static and dynamic panel data.

The variable (LogDGDP) used to evaluate the similarities between trade partners presents a positive correlation on IIT, when we used OLS estimator with time dummies, TOBIT model, and GMM-System. These results are contradictory with the literature (Loertscher and Wolter (1980) found a negative sign). Our results show that the higher the difference in GDP per capita between Portugal and trade partner, the higher will be IIT, in the automobile components. As automobile components are mainly vertical specialization, this can explain the positive coefficient of this variable. In relationship the variable differences in physical capital endowments (LogEP), our results validate the hypothesis: IIT occurs more frequently among countries that are similar in terms of factor endowments.

The proxies used to economic (DIM) and cultural (US) dimension, are according to the literature, i.e. the market size and culture benefit and influence the volume of trade. Turkcan (2005) shows that market size is necessary to differentiate products. The study of Chemsripong et al. (2005) also shows that culture is positively relate to IIT. It is usual that the literature attributes a negative sign to geographical distance, i.e. trade increases if the partners are geographically close. For the difference between in factor endowments, the literature refers a negative sign. The proxy EUxDGDP confirmed this, but the coefficient of EUxEP presents a contradictory sign. This study has some limitations. In the future, we need to improve research on vertical intra-industry trade, because this sector is associated to two-way trade of different endowments and quality products. To separate total IIT in HIIT and VIIT we need to apply the methodology by Abel-el-Rahaman (1991), and Greenaway et al. (1994, 1995).

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