INTRA-INDUSTRY TRADE IN THE FOOD PROCESSING SECTOR: THE PORTUGUESE CASE

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ABSTRACT

This paper analyses the determinants of intra-industry trade (IIT) in the Portuguese food processing sector. The study uses both industry and country–specific characteristics as explanatory variables. The results indicate that IIT in this sector is a positive function of the difference in GDP per capita between Portugal and its European trade partners. Statistically strong evidence is also found that this trade is influenced by the geographical distance between trading partners. Using industry-specific characteristics, the results also show that this type of trade is negatively influenced by industrial concentration. In addition, the foreign direct investment inflows have a positive influence on Portuguese bilateral IIT, although this variable is not statistically significant.

INTRODUCTION

In general, there are two types of trade: inter-industry and intra-industry trade (IIT). Nowadays in the developed world, most trade is of the IIT type - the simultaneous export and import of products within the same industry. The traditional theories on trade, based on constant returns to scale, homogeneous product and perfect competition, could explain inter-industry trade (Ricardian trade theory and Heckscher-Ohlin trade theory). Theoretical explanations of IIT started to appear in the late 1970s. The pioneering models in IIT are due to Krugman (1979), Lancaster (1980), Helpman (1981), Eaton and Kierzkowski (1984) and Helpman and Krugman (1985). All these models consider that products are differentiated and emphasize the imperfect competition in industrial markets, particularly the scale economies and industrial concentration.

Linder (1961) considered that consumers' tastes are conditioned by their income levels. These tastes yield demands for products and this demand structure generates a production response. Hence, countries with similar per-capita incomes will have similar demand structures and will export similar goods. The Linder theory of overlapping demands proposes that goods must first be produced for home markets and then exported to similar countries.

Numerous empirical studies have attempted to identify the determinants of IIT. Following Greenaway et al. (1994, 1995), we can divide these studies into two groups: country-specific studies and industry-specific studies. The country-specific studies explain IIT through the macroeconomic variables in each country, such as

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per-capita income, economic dimension, distance, relative factor endowments and foreign direct investment. Industry-specific studies explain IIT as a function of industry-specific variables, such as scale economies, product differentiation and firm concentration ratio. It is a fact that most of the empirical studies on IIT find more empirical support for country–specific determinants than for industry-specific determinants. The present paper, as other studies, combines both country and industry variables to explain IIT.

Most studies of intra-industry trade (IIT) exclude the food processing sector. Empirical studies on the IIT in this sector have been limited, with some exceptions (see, for example, Pelzman, 1977; McCorriston and Sheldon, 1991; Hirschberg et al., 1994; Neff et al., 1996; Qasmi and Fausti, 2001; Sharma, 2002). Pelzman (1977) was the first to investigate the question of intra-industry trade among centrally planned economies. More recently Bojnec (2001) studied this type of trade for Central and Eastern European countries (CEECs). McCorriston and Sheldon (1991) conducted a study on IIT for U.S agricultural products. The authors found that U.S and world trade in processed agricultural products was essentially of the inter-industry type. For EC trade, McCorriston and Sheldon (1991) concluded that this trade was also essentially of the IIT type. Sharma (2002) concluded that product differentiation and scale economies contribute positively to IIT, and trade protection discourages IIT. The studies of Sharma (2002) and Qasmi and Fausti (2001) show that inter-industry trade is predominant in this sector.Fertö (2005) studied the relationship between factor endowments and vertical IIT in agri-food products traded between Hungary and the EU. Based on the Flam and Helpman (1987) model, Fertö (2005) conducted a panel data regression analysis to explain vertical IIT. The results suggest that there is a positive relationship between VIIT and differences in factor endowments, which was predicted by the theory.

There are good reasons for studying the food processing sector in Portugal. Firstly, after the entry of Portugal into the European Economic Community (EEC) in 1986, the implementation of the Common Agricultural Policy (CAP) and its reform in 1992 that created new standards and norms for the agricultural sector and rural areas in general, there has been a deep transformation of this sector. Secondly, while Portuguese food processing has been considered a traditional sector, there are no recent studies on the structural changes in this sector using Grubel and Lloyd's (1975) IIT index and econometric methods. Thirdly, the Helpman and Krugman (1985) model has been used to test industry and country-specific determinants of total IIT. It seems reasonable to use the same framework to analyse bilateral IIT in the food processing sector, despite the fact that IIT is not predominant (the IIT index is over 40%, but below 50%. See Table 1). Finally, the results provide evidence that the determinants of this type of IIT are not very different from the determinants of all IIT. In this case, there is no reason to view this sector as either traditional or problematic.

This study examines IIT between Portugal and the European Union (EU15), in the food processing sector, using a balanced panel for the period 1996-2003 (for other features of our empirical work, namely, the evolution of IIT indexes, the period is 1995-2003).

In static panel data models, Pooled OLS, fixed-effects (FE) and random-effects (RE) estimators are used (see Hummels and Levinsohn, 1995; Zhang et. al., 2005). The RE estimator was excluded because our sample is not random. We decided against using the fixed-effects estimator, as some relevant variables do not vary along the time. Therefore, the regression coefficients are estimated using OLS with time dummies.

The paper is organized as follows: the next section explains IIT based on the Helpman-Krugman model. In the third section, we present the recent evolution of the IIT index in the food processing sector and in Portuguese industry as a whole. The fourth section presents the econometric model, while the fifth section analyses the results. Finally, we make our concluding remarks in the final section.

EXPLAINING INTRA-INDUSTRY TRADE

The IIT literature began in the 1960s, when Balassa (1966) pointed out that most of the growth in manufacturing followed the formation of a customs union in Europe.

Grubel and Lloyd (1975) introduced a comprehensive index to measure IIT and developed supporting evidence of IIT in a number of developed countries.

The first theoretical models of IIT were synthesized in Helpman and Krugman's model, which is a Chamberlin-Heckscher-Ohlin model. This is a model that combines monopolistic competition with the Heckscher-Ohlin (HO) theory, incorporating factor endowments differences, horizontal product differentiation and increasing returns to scale.

Following Helpman (1981) and Helpman and Krugman (1985), we consider two countries (home and foreign), and two goods (X and Y). The good X is intensive in capital (K), and Y in labour (L). The home country is relatively abundant in K, and the host country in L. HecKscher-Ohlin factors explain inter-industry specialization, while economies of scale and horizontal product differentiation explain IIT.

The Volume of Trade (VT) is equal to:

$$VT = p\left(X - s\overline{X}\right) + \left(Y^* - s^*\overline{Y}\right) \tag{1}$$

Where:

- p is the price of manufactures and Y is taken as numeraire;

- X, (X^*) is the output of X in the home (foreign country);

Y, (Y^*) is the output of Y in the home (foreign) country;

$\overline{X}$,($\overline{Y}$) is the world output of X (Y);

s, (s^*), is the share of the home (foreign) country in world income and spending.

As it is assumed that X is horizontally differentiated with increasing returns to scale and p is the price of differentiated goods, the home country exports X and imports Y, under the hypothesis of free entry and exit. The model concludes that each variety is produced by only one firm in one country but the firms that produce X can be located in both countries. However, the home country will be the net exporter of X. If trade is balanced, and considering that there are no transport costs, VT equals twice the exports of the home country.

$$VT = 2s^* pX \tag{2}$$

Considering that the total IIT is twice the minimum between exports and imports, i.e. it is twice the exports of differentiated products by the net importing foreign country, that is:

$$IIT = 2s\ pX^* \tag{3}$$

Then the Grubel and Lloyd (1975) index (the IIT) is given by:

$$\frac{2spX^*}{2s^* px} = \frac{sX^*}{s^* X} \tag{4}$$

The IIT index as given by (4) depends on the relative factor endowments and other country characteristics. Therefore, we can test the hypothesis that the larger the difference in factor endowments, the less will be the share of intra-industry trade (IIT). Moreover, we must consider some variables such as per-capita income difference, size of market, economies of scale, product differentiation and geographical distance.

THE RECENT TREND IN PORTUGUESE INTRA-INDUSTRY TRADE

The level of IIT is generally measured by the so-called Grubel and Lloyd (1975) index. They defined IIT as the difference between the trade balance of industry i and the total trade of this same industry. In order to make the comparison easier between industries or countries, the index is presented as a ratio in which the denominator is total trade.

$$IIT = 1 - \frac{\left|X_i - M_I\right|}{\left(X_i + M_i\right)} \Leftrightarrow IIT = \frac{\left(X_i + M_i\right) - \left|X_i - M_i\right|}{\left(X_i + M_i\right)} \tag{5}$$

The index is equal to 1 if all trade is of the intra-industry trade type. If IIT is equal to 0, all trade is inter-industry trade.

Table 1: Intra-Industry Trade in the Portuguese Food Processing Sector and in the Total Industry

	1995	1996	1997	1998	1999	2000	2001	2002	2003
IIT food processing sector	0.404	0.417	0.413	0.427	0.437	0.448	0.411	0.421	0.411
IIT total industry	0.491	0.521	0.544	0.537	0.540	0.543	0.507	0.589	0.596

As shown in Table 1, the IIT between Portugal and the European Union (EU15) for the food processing sector, accounts for more than 40% in the period 1995-2003. The pattern of IIT is maintained from 1995. When we compare this value with the value for the total industry IIT, we note that the index for this sector is below the average value for total industry. The above table shows that IIT in total industry increased substantially from 0.491 in 1995 to 0.596 in 2003. However, the results for the food processing sector are in accordance with the results found for other developed countries like Portugal (see Sharma, 2002; Qasmi et al., 2001). This means that bilateral agricultural trade flows between Portugal and the EU15 can be explained by non-comparative advantage factors, such as product differentiation and scale economies. It can also be explained by comparative advantage factors, such as factor endowment differences. This idea is reinforced if we take into account that total IIT is largely vertical, which means that this trade is mainly in products differentiated by quality (see Table 2). In this case, the vertical IIT (VIIT) is explained by traditional trade theories of comparative advantage (see Flam and Helpman, 1987; Davis, 1995), whereas horizontal IIT (HIIT) is explained by economies of scale and product differentiation.

Table 2: Trade between Portugal and the European Union (EU15) by types

	1995	1996	1997	1998	1999	2000	2001	2002	2003
IIT	0.491	0.521	0.544	0.537	0.540	0.543	0.507	0.589	0.596
VIIT	0.267	0.297	0.288	0.273	0.328	0.456	0.389	0.430	0.377
HIIT	0.224	0.224	0.256	0.264	0.212	0.087	0.118	0.159	0.219

ECONOMETRIC MODEL

The dependent variable used is the IIT Grubel and Lloyd (1975) index. The explanatory variables are country and industry-specific characteristics. The data sources for the explanatory variables are the World Bank, World Development Indicators (2005), the Portuguese Ministry of Labor (Quadros de Pessoal), the Portuguese National Institute of Statistics (INE) - Statistics of Firms, and the Bank of Portugal. The source used for the dependent variables was the INE - Trade Statistics.

EXPLANATORY VARIABLES

In accordance with the theory, we have chosen the following explanatory variables:

- Economic differences between countries (DGDP): this is the difference in GDP per capita (PPP, in current international dollars) between Portugal and the European trading partner. Loertscher and Wolter (1980) and Greenaway et al. (1994) provide empirical support for a negative relation between the difference in per-capita income and IIT. Linder (1961) considers that countries with similar demands will trade similar products. So, the Linder (1961) hypothesis suggests a negative sign for the coefficient of this variable.Linder (1961) uses per-capita income differences as a proxy for consumer tastes and preferences. It has been argued that as per-capita incomes of two countries become equal, the tastes and preferences of their respective consumers also become similar. Hence, the share of IIT rises as the difference in per-capita income declines. Helpman and Krugman (1985) consider differences in per-capita income as differences in the capital-labor ratio.

As per-capita income reflects both the demand and supply sides, Hummels and Levinshon (1995) alternatively employ per-capita income and factor ratios. In this paper, we consider different variables for demand and supply sides and we will use two proxy variables for factor endowment differences. Thus, as discussed in Helpman and Krugman (1985), there is an expected negative relationship between IIT and differences in factor endowments;

- Physical endowments (EP): this is a proxy for differences in physical capital endowments (Kwh per capita) between Portugal and its European partner. Hummels and Levinsohn (1995), Helpman and Krugman (1985) and Helpman (1981) considered a negative relation between IIT and differences in factor endowments;

- EC: this is the difference in energy consumption (kg of oil equivalent per capita) between Portugal and the European partner. It is used as the second proxy for physical capital endowments;

-MinGDP: this is the lowest value of GDP per capita (PPP, in current international dollars) between Portugal and the European partner. This variable is included to control for relative size effects. According to Helpman (1987) and Hummels and Levinshon (1995), a positive sign is expected, which is consistent with the hypothesis of a negative correlation between the share of IIT and dissimilarity in per-capita GDP;

- MaxGDP: this is the higher/highest value of GDP per capita (PPP, in current international dollars) between Portugal and the European partner. This variable is also included to control for relative size effects. A negative sign is expected, as in Helpman (1987), Hummels and Levinshon (1995) and Greenaway et al. (1994). A negative sign is consistent with the hypothesis that the more similar countries are in economic dimension, the greater the IIT between them;

- DIST: this is the geographical distance between the Portugal and partner country. Balassa (1986) argues that IIT will be greater when trading partners are geographically close. A longer distance will increase the transaction and transportation costs. Thus, there is a negative relationship between the share of IIT in the industry and geographical distance. Hummels and Levinshon (1995) found a negative sign;

- PD (Horizontal product differentiation)*: the variable proxy is the Hufbauer index, i.e variation of export unit values. $H = \frac{\sigma_{ij}}{\overline{x}_{ij}}$ .Where σ_{ij} = standard deviation of export unit values, and $\overline{x}_{ij}$ = unweighted mean of those unit values (see Greenaway and Milner, 1986; Gray, 1988). Greenaway and Milner (1986) expected a positive sign. According to Helpman and Krugman (1985), the share of IIT is expected to be positively related to product differentiation;

- MES (Minimum Efficient Scale): the variable proxy is the average size of the enterprises. It is the value of production divided by the number of firms. The theoretical sign is ambiguous. If we consider a large number of

firms (dominant paradigm), we expect a negative sign, as in Greenaway et al. (1994). Greenaway considers that the small-scale economies at the plant level imply greater scope for firm entry and product differentiation .Sharma (2002) found a positive sign in his empirical study, which is in accordance with the paradigm of a small number of firms.;

- CONC (Industrial Concentration): this is a percentage of industry sales of the four largest firms in total sales plus imports of the industry. The sign could be positive or negative. The dominant paradigm of a larger number of firms considers a negative sign. If we consider a small number of the firms in the market, the coefficient sign expected is positive;

- FDI (Foreign Direct Investment inflows): the relationship between IIT and the level of FDI in a particular industry is somewhat ambiguous since FDI may be a substitute for the trade. Gray (1988) considers an ambiguous relationship between FDI and IIT. Greenaway et al. (1994) estimated a positive sign for the coefficient of this variable;

- TIMB (Trade imbalance): Following Lee (1993) the paper considers the trade imbalance as a control variable, where TIMB is defined as:

$$TIMB_j = \frac{\left| X_j - M_j \right|}{\left(X_j + M_j \right)} \tag{6}$$

This variable represents the net trade as a share of trade and takes a value of zero at the lower extreme if there is no trade imbalance and a value of one if there are neither exports nor imports. According to the theory, a negative correlation between this control variable and IIT is expected.

MODEL SPECIFICATION

$$IIT_{it} = \beta_0 + \beta_1 X_{it} + \varepsilon_{it} \tag{7}$$

Where IIT is the Portuguese IIT index, X is a set of countries and industry-specific explanatory variables in logs. e_{it} is a random disturbance assumed to be normal, independent and identical distributed (IID) with E (eit) =0 and Var (eit) = s^2 >0.

Since IIT is an index varying between zero and one, we apply a logistic transformation to IIT, as in Hummels and Levinsohn (1995). $IIT = \ln\left[IIT / (1 - IIT) \right]$. We decided against using the fixed-effects estimator, because some relevant variables such as distance do not vary along the time. We control for time effects by including a time dummy variable and the regression coefficients are estimated using OLS with time dummies.

ESTIMATION RESULTS

In this section we present the results with country and industry characteristics as explanatory variables. In Table 3, we can observe the country-specific determinants of intra-industry trade in the food processing sector, together with the estimated coefficients. The general performance of the model is satisfactory (Adjusted R^2 = 0.515)

Table 3: The country-specific determinants of intra-industry trade

Variables	Coefficient	Expected Signs
LogDGDP	2.502 (3.56)***	(-)
LogEP	-1.373 (-2.69)***	(-)
LogEC	1.492 (3.18)***	(-)
LogMinGDP	-5.316 (-1.80)*	(+)
LogMaxGDP	-6.225 (-3.09)***	(-)
LogDIST	-2.786 (-4.66)***	(-)
C	47.420 (2.71)	
Adj. R^2	0.515	
Observations	104	

OLS estimator with time dummies. T-statistics (heteroskedasticity corrected) are in round brackets.
***/*- statistically significant, respectively at the 1% and 10% levels

All explanatory variables are significant at the 1 % level, with the exception of LogMinGDP, which is statistically significant at the 5 % level.

The difference between per-capita incomes, in logs, (LogDGDP) presents a positive sign and is significant at the 1 % level. However, the positive estimated sign was not expected. Our results show that the higher the difference in GDP per capita (PPP, in current international dollars) between Portugal and the European trade partner, the higher will be the IIT in the food processing sector. As Portuguese IIT is mainly the vertical IIT (VIIT) type, this can explain the positive sign for the coefficient of this variable. This is in accordance with the neo-Heckscher-Ohlin trade theory, which also explains VIIT by the differences in countries' levels of development. However, we would need to test this hypothesis using VIIT as a dependent variable.

Following Falvey and Kierzkowski (1987), we introduced two proxies for the difference in factor endowments (electric power, and energy consumption). The variable, electric power in logs (LogEP) presents a negative sign, confirming the theoretical forecast proposed by Hummels and Levinsohn (1995). However, the same conclusion cannot be drawn for the energy consumption variable (LogEC), which has an unexpected positive sign. The exclusion of one of the proxies did not resolve the problem of finding opposite signs to different proxies. The solution could be to use capital/labor ratios. Unfortunately, this data is not freely available.

Following Helpman and Krugman (1985) and Hummels and Levinsohn (1995), the study also includes two variables to control for relative size effects. Both are statistically significant, although only the higher value of GDP per capita in logs (LogMaxGDP) has an expected negative sign.

The geographical distance 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.

In Table 4, we can observe the determinants of intra-industry trade using industry characteristics as explanatory variables.

Table 4: The industry-specific determinants of intra-industry trade

Variables	Coefficient	Expected sign
PD	0.064 (0.356)	(+)
MES	0.459 (2.12)**	(- ; +)
CONC	-13.292 (-1.80)*	(- ; +)
FDI	7.56 E-007 (0.585)	(+)
TIMB	2.139 (3.19)***	(-)
C	-3.084 (-3.24)	
Adj. R^2	0.30	
Observations	104	

OLS estimator with time dummies

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

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

The coefficients of product differentiation (PD) and foreign direct investment (FDI) are positive, but not statistically significant. However, the expected sign and the estimated sign are the same. So, we can say that there is some empirical evidence (not statistically significant) to support the hypothesis that the higher the horizontal product differentiation and the foreign direct investment inflows, the higher will be the IIT in the food processing sector.

The variable, economies of scale (MES) is statistically significant and has a positive effect on IIT in the food processing sector, as expected. The results also show that the industrial concentration has a negative effect on IIT, which is in accordance with the hypothesis of a large number of firms in the market, namely, the higher the industrial concentration, the lower will be the ITT in the food processing sector. This result provides empirical evidence that the structure of the market for this type of product is characterized by a larger number of firms (the theoretical dominant paradigm). The control variable (TIMB) is statistically significant at 1%, but with a negative sign.

Thus, we can say that the main industry determinants of this two-way trade in agro-food products are (internal) economies of scale and product differentiation. The structure of the market can be identified as monopolistic competition.

CONCLUSIONS

Most of the analyses conducted on agro-food trade are still based on the traditional theories of comparative advantages (Ricardo and Heckscher-Ohlin models). Only in the last decade has attention turned to the new trade theories and the application of the new concepts to agro-food trade. The new trade theories assume internal economies of scale, product differentiation and imperfect competition. Thus, the market structure is of importance in explaining the trade in the food processing sector. If we consider that the market structure is characterized by monopolistic competition, the food processing industry contains a sufficient number of similar firms producing similar products. These are not homogeneous, but differentiated products. Different varieties of products are produced in different countries. This allows the intra-industry trade. Our results confirm that in Portugal, this new type of trade is also important in this specific industry.

Agro intra-industry trade between Portugal and the European Union (EU) accounted for over 40% for the period 1995-2003. These results illuminate the importance of intra-industry trade in this sector and these values are in accordance with those found by other studies in the developed countries.

Comparing our findings with other empirical studies (see, for example, Sharma, 2002; Qasmi and Fausti, 2001), we obtained similar results. Econometric estimations support most of the theoretical hypotheses based on the new trade theory. Internal economies of scale and market structure are important explanatory variables of the IIT in the food processing sector. The Linder hypothesis (i.e. countries with similar demands will trade similar products) was also tested. However, our study has some limitations. We need to introduce a

dynamic analysis using Brulhart(1994) marginal IIT index. Furthermore, an expansion of the research would be to disentangle IIT into vertical IIT and horizontal IIT, because these different types of IIT may have different determinants. The methodology by which to separate HIIT from VIIT is available, having been pioneered by Abel-el-Rahman (1991), and Greenaway et al. (1994).

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