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Fragmentation in the automobile manufacturing industry: evidence from Portugal

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Abstract

Purpose – This paper aims to examine the determinants of vertical intra-industry trade (VIIT) in the automobile components industry between Portugal and the European Union 27 (EU-27) and the BRIC countries (Brazil, Russia, India and China) during the period 1995-2006.

Design/methodology/approach – The paper formulates some theoretical hypotheses that may explain the fragmentation of the production in the automobile industry. These hypotheses are tested using a dynamic panel data analysis. The estimates are more reliable because the instruments used control for the potential endogeneity of the explanatory variables.

Findings – The results indicate that VIIT is a positive function of the difference in per-capita GDP between Portugal and its trading partners, confirming the Linder hypothesis. Moreover, there is statistical evidence that geographical distance influences negatively this type of VIIT between Portugal and the EU-27 only. The results do not confirm the hypothesis that there is a positive correlation between differences in endowments and VIIT in the automobile components sector.

Originality/value – This paper confirms some relevant theoretical hypotheses on the causes of the fragmentation/outsourcing. The good results obtained with the Arellano and Bond GMM system estimator suggest that the building of dynamic theoretical models will be of interest to academic researchers in fragmentation theory.

Keywords VIIT, Intermediate goods, Automobile manufacturing industry, Panel data, Fragmentation, Globalization, Automotive industry, Portugal

Paper type Research paper

1. Introduction

The role of the multinational corporations (MNC) in the fragmentation/outsourcing of their production can be observed through the statistics dealing with international trade. Since the 1970s, approximately one-third of US exports and imports have taken the form of sales by one unit of an MNC to another unit. The trade in automobile components between different units of multinational corporations is a good example of this type of trade, that is, vertical intra-industry trade (VIIT).

The term outsourcing is often used to describe cases in which an MNC relocates part of its production away from the home country to another country. In most cases, the foreign firm is a subsidiary of the MNC. In other cases, the MNC subcontracts the

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operation concerned to a foreign firm. Outsourcing is discussed in the context that MNCs are purchasing inputs from abroad. Outsourcing has grown because firms seek to reduce labour-market costs. Global networks created by MNCs are found in various industries, but are qualitatively and quantitatively most important in the machinery industries, including general machinery, electrical machinery, transport equipment and precision machinery.

Olsen (2006, p. 6) considers that we should use the term "offshore outsourcing", which: "covers the relocation of jobs or processes to an external and internationally located provider". Outsourcing includes job relocations within and between countries, whereas offshoring applies only to international relocations. So, following Olsen (2006), we should use the concept offshoring in the case of MNC, which implies the international relocation of jobs and processes, both to units belonging to the same MNC and to external units. Fragmentation of production occurs when the production of a final good requires multiple stages. Fragmentation occurs not only across regions within a country but also across countries. This paper uses outsourcing and fragmentation as synonyms and following Olsen's (2006) suggestions, offshore outsourcing means international fragmentation/outsourcing.

VIIT in parts and components reflects the exchange of intermediate goods which belong to the same industry, but which are located at different stages in the production process. This VIIT index is used as a measure of fragmented trade. Following recent literature, we apply country-specific variables, such as per-capita income, distance, relative factor endowment, and shared borders, to explain VIIT.

This study analyses the determinants of VIIT between Portugal and 21 countries of the European Union 27 (EU-27), three of the BRIC countries (Brazil, China and India) and the USA in the automobile parts and components industry[1]. The paper uses an unbalanced panel for the period 1995-2006. We have followed such other empirical studies as Turkcan (2003, 2005), Clark (2006), Wakasugi (2007), Kimura *et al.* (2007), Yoshida (2005), Reis and Rua (2006), and Amador and Cabral (2008). However, we will specify a different econometric model and we will use a different estimator.

In static panel data, pooled OLS, fixed-effects (FE) and random-effects (RE) estimators are used in this type of study. We decided to introduce a dynamic panel data. The estimator used (GMM-SYS) permits researchers to solve the problems of serial correlation, heteroskedasticity and controls for the potential endogeneity of some explanatory variables. These econometric problems were solved by Arellano and Bond (1991), Arellano and Bover (1995), Blundell and Bond (1998, 2000), who developed the first-differenced GMM estimator (GMM-DIF) and GMM system estimator (GMM-SYS). In this paper, we will use the GMM-SYS. This type of dynamic analysis is usual in empirical studies on firms' and employment growth, income growth and financial development and economic growth (see, for example, Arellano and Bond, 1991; Blundell and Bond, 2000; Glytsos, 2005; Ferreira, 2008; Seetanah *et al.*, 2009).

The remainder of the paper is organised as follows. The second section reviews the theoretical literature. The third section analyses the relationship between fragmentation and vertical intra-industry trade. The fourth section reports the recent trend in Portuguese vertical intra-industry trade. The fifth section presents the econometric model. In the sixth section, we analyse the results and the final section concludes.

2. Literature review

Hummels *et al.* (1998), examining the importance of trade in intermediate goods, have used a vertical specialisation index as a measure of fragmentation. According to their approach, vertical specialisation occurs when a country uses imported intermediate goods to produce goods that will be exported later. If the country does not export them later, outsourcing has occurred, but vertical specialisation has not. The "fragmentation" concept was first proposed by Jones and Kierzkowski (1990). However, different authors use different terms: fragmentation (Deardorff, 1998); outsourcing (Feenstra and Hanson, 1996); vertical specialisation (Hummels *et al.*, 1998); disintegration of production (Feenstra, 1998); and intra-product specialisation (Arndt, 1997). Nevertheless, the term fragmentation is generally used in trade theory and empirical studies. Hummels *et al.* (1998) explained the growth of vertical specialisation. The authors concluded that international integration involves the interconnection of the production process in vertical trading across various countries.

The fragmentation of production highlights the relevance of transport costs between different countries. This had already been taken into account by the new economic geography (Krugman, 1991a, b). Transport costs, associated with increasing returns to scale, is an important explanatory variable in the core-periphery models to justify the firm's location. In this model, as in the Krugman (1979, 1980) intra-industry models based on monopolistic competition, the scale economies are internal to the firm.

In Jones and Kierzkowski's (1990) fragmentation theory, the increasing returns may or may not occur. The location of part of the integrated production is explained by other reasons and the production by blocks may occur under constant returns to scale. The final production is a sequence of production of components that should be linked together. The labour costs and labour productivity (differences in relative factor endowments), the transport and communication costs, distance and cultural ties that contribute to reduce the component costs, technological progress and development of new technologies that facilitates production by blocks, the country's bureaucracy and corruption, the country's regulations that impede or facilitate FDI, the fiscal incentives to attract FDI, the costs of connecting production blocks and costs of connecting service links, as well as deregulation of service activities both nationally and between countries, are all variables that should be considered.

Fragmentation of production among East Asian countries is widely supported by empirical evidence. Ando (2006) studied fragmentation and vertical intra-industry trade (VIIT) in East Asia. The author concluded that vertical international production has become an essential part of every economy in East Asia. In the 1990s, an increase took place in the vertical specialisation in special machinery parts and components.

Kimura *et al.* (2007) analysed the determinants of fragmentation in the machinery parts and components production among East Asian, European and other countries. In a gravity model, the parts and components trade is regressed on the difference of GDP per capita, in addition to the incomes of trading countries and the distance between them. The authors find that a larger income gap increases the components trade among East Asian countries, while similar incomes promotes larger components trade among European countries. They conclude that trade in components among East Asian countries is more a case of vertical trade driven by the fragmentation of machinery production.

Yoshida (2005) examines regional trade in automotive parts and components among Asian countries. By using Japanese FDI, distinguishing automobile constructors such as Toyota and Honda from automobile components suppliers such as Denso, empirical results show that FDI by automotive parts suppliers promotes the components trade among Asian countries, regardless of whether a host country is an importer or exporter, whereas FDI by automobile makers only contributes to promoting regional trade in components when a host country is an importer.

While empirical evidence on fragmentation in Asia is substantial, it is less so with regard to Europe. In this paper, we attempt to fill this gap. We seek to provide empirical evidence on fragmentation among European countries, particularly from the perspective of a small, medium-income country, i.e. Portugal. In addition, departing from the use of uni-directional trade flows, as found in the existing literature, we use a vertical intra-industry trade index for automobile components as a dependent variable. Our paper, focusing on the automobile sector in the EU, and taking into account bilateral partners such as the USA, Brazil, China, and India, is also a complementary study to those works that only examine the automobile components trade in an economic integration area.

3. Fragmentation and vertical intra-industry trade

When the production of the finished good requires multiple stages, we have fragmentation, or outsourcing. As Turkcan (2003) points out, before the 1960s, firms produced for themselves all of the components used in assembling the final good. However, the costs of producing the final product and the intermediate goods have increased as time has progressed. With globalisation, the world economy presents new clusters of industries. For example, India (see Eiteam *et al.*, 2007) has developed a highly efficient, low-cost software industry. In China, the principal activities are chemical, mechanical and petroleum-engineering services. Russia has developed software and engineering services and R&D centres. Japan and Mexico are highly efficient in car manufacturing and electronic services.

According to Kol and Rayment (1989), the exchange of intermediate goods can be divided into horizontal IIT and vertical IIT. Kol and Rayment (1989) suggest taking the unit values of exports and imports of intermediate goods to separate total IIT into its horizontal and vertical components.

Horizontal intra-industry trade in intermediate goods cannot be explained by the factor proportions theory, because we have the same quality, costs and factor proportions (K, L) employed in the production.

Vertical intra-industry trade in intermediate products can be explained by the HO (Heckscher-Ohlin) model, associated with multiple stages of production.

How can we create a measure based on vertical intra-industry trade? This may be done using the Grubel and Lloyd (1975) intra-industry trade index.

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:

$$IIT_i = 1 - \frac{|X_i - M_i|}{(X_i + M_i)} \tag{1}$$

The index is equal to 1 if all trade is intra-industry. If IIT_i is equal to 0, all trade is inter-industry trade.

To determine the horizontal and vertical intra-industry trade, Grubel and Lloyd indexes and the methodology of Abd-El-Rahman (1991) and Greenaway *et al.* (1994) are used:

$$HIIT_i = \frac{RH}{(X_i + M_i)} \tag{2}$$

- HIIT – horizontal intra-industry trade index.
- RH – total horizontal intra-industry trade.
- TT_i – relative unit values of exports and imports are used to disentangle HIIT and VIIT.

If $TT_i \in [0.85; 1.15]$, we have horizontal IIT:

$$VIIT_i = \frac{RV}{(X_i + M_i)} \tag{3}$$

- VIIT – vertical intra-industry trade index.
- RV – total vertical intra-industry trade.

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

4. The recent trend in Portuguese vertical intra-industry trade: the car industry

As Table I shows, the Portuguese VIIT in automobile components accounts for more than 40 per cent in the period 2000-2006, with the exception of 2003.

The same is valid for the year 1995. For the period 1996-1998, car components account for more than 30 per cent. When we compare these values with the total car industry, we note that the index of VIIT decreases. For the period 1999-2005, the total car industry VIIT exceeds 20 per cent.

5. Econometric model

The dependent variable used is vertical intra-industry trade (VIIT) in the automobile components industry. It is calculated with the disaggregation of five digits of the economic activities classification of the automobile components. The data for the explanatory variables is sourced from the World Bank (2005). The source used for the dependent variable was INE – the Portuguese National Institute of Statistics.

Table I.
Vertical intra-industry trade in the Portuguese components sector and in the total car industry

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Parts and components	0.46	0.32	0.37	0.35	0.39	0.49	0.49	0.43	0.38	0.44	0.59	0.51
Car industry	0.18	0.17	0.27	0.30	0.26	0.29	0.24	0.26	0.23	0.22	0.22	0.09

5.1 Theoretical hypotheses and definition of explanatory variables

The paper will test the following hypotheses:

H1. There is a positive relationship between differences in per-capita income and VIIT.

LogDGDP is the logarithm of absolute difference in per-capita GDP (PPP, in current international dollars) between Portugal and the trading partner. Falvey and Kierzkowski (1987) suggest a positive sign for the coefficient of this variable in the VIIT model. Turkcan (2005) and Wakasugi (2007) found a positive relationship between these two variables when they studied the fragmentation of production in transactions of parts and intermediate goods.

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. Linder's (1961) theory can also explain VIIT in parts and components. According to Linder's (1961) hypothesis, a positive relationship between income differences and VIIT in the automobile components industry is to be expected. Countries with low per-capita incomes specialise in, and export, low-quality varieties of the same product, whereas countries with high per-capita incomes specialise in, and export, high-quality varieties of the same product. So, Linder's theory proposes that the higher the difference in per-capita income, the greater the VIIT. Helpman and Krugman (1985) considered that per-capita income differences may be used as a proxy for differences in relative factor endowments (capital-labour ratio). However, there is not consensus on this.

We also introduced an interaction involving a dummy variable, EU, and the explanatory variable LogDGDP. The dummy variable assumes the value 1 if the country belongs to the EU-27 and 0 otherwise. The introduction of the variable EUxLogDGDP allows us to determine whether there is a statistically significant interaction between the difference in per-capita GDP and the condition of the European partner-country:

H2. VIIT occurs more frequently among countries that are different 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), we expect a positive sign for the coefficient of this explanatory variable. Zhan *et al.* (2005) found a positive sign for the Chinese case.

There is a consensus that traditional trade theory of comparative advantages (Hecscher-Ohlin theory) can also explain the fragmentation trade (see Deardorff, 1998; Jones and Kierzkowski, 2001):

H3. The trade increases if the transportation cost decreases.

LogDIST is the logarithm of the geographical distance between Portugal and the partner-country. This variable is used to proxy the cost of transports and, according to the literature, a negative sign is expected (see Balassa, 1986; Matthews, 1998; Clark, 2006).

Our study also considered an interaction involving a dummy variable and the explanatory variable. EUxLogDIST is an interaction between the dummy variable EU (which equals 1 if the country is a European trading partner and zero otherwise) and the variable distance (LogDIST). The introduction of a slope dummy variable allows us to test the hypothesis that the effects of distance on trade are different for Portuguese European partners (EU-27) and for the others (non-EU-27).

5.2 Model specification

Considering these hypotheses, we decided to specify the following econometric model:

$$VIIT_{ijt} = \beta_0 + \beta_1 X_{ijt} + \delta t + \eta_{ij} + \varepsilon_{ijt} \quad (5)$$

Where $VIIT_{ijt}$ is the Portuguese VIIT index and X is a set of explanatory variables. It includes the country-specific explanatory variables and the multiplicative dummy variables. All variables except the dummy variables are in the logarithmic form; η_{ij} is the unobserved time-invariant specific effects; δt captures a common deterministic trend; ε_{ijt} is a random disturbance assumed to be normal and identically distributed (*IID*) with $E(\varepsilon_{ijt}) = 0$; $Var(\varepsilon_{ijt}) = \sigma^2$o.

The model can be rewritten in the following dynamic representation:

$$VIIT_{ijt} = \beta_0 + \rho VIIT_{ijt-1} + \beta_1 X_{ijt} + \beta_2 X_{ijt-1} + \delta t + \eta_{ij} + U_{ijt} \quad (6)$$

Since VIIT is an index varying between zero and one, we apply a logistic transformation to VIIT, as in Hummels and Levinshon (1995). $VIIT = Ln[VIIT/(1 - VIIT)]$[2].

6. Estimation results

Table II presents summary statistics for each variable. LogDGDP, LogEP, LogDIST and EUxLogDGDP appear to have only little differences in their means and medians, implying a more symmetrical distribution. However, this is not the case for LogiVIIT and EUxLogDIST, where the difference between the mean and the median is significant. With regard to the number of observations for each variable, we note that the dependent variable LogiVIIT has only 223 observations, because the log function is not defined when the VIIT index is zero. Also, the variable LogEP has only 264 observations because the data for the year 2006 is missing for some countries.

Table III presents the estimates of the dynamic fixed effects model, using GMM-System estimator[3]. The general performance of the model is satisfactory. The dynamic model presents consistent estimates, with no serial correlation for the GMM-SYS estimator (m2 statistic). The specification Sargan test shows that there are

Variable	Mean	Median	SD	Min	Max	Observations
LogiVIIT	0.13589	0.331246	2.20893	−8.61339	8.85968	223
LogDGDP	3.78635	3.95693	0.53397	0.707008	4.36404	228
LogEP	3.29795	3.35315	0.46426	1.00307	4.09311	264
LogDIST	3.12429	3.12516	0.29836	2.42814	3.73175	287
EUxLogDGDP	3.09598	3.05461	1.47685	0	4.30005	288
EUxLogDIST	2.52017	3.83787	1.14883	0	3.25839	287

Table II. Summary statistics

Variables	GMM-SYS	Expected sign
$LogiVIIT_{it-1}$	0.285 (1.63)*	(+)
LogDGDP	−23.55 (−1.74)*	(+)
LogEP	1.002 (0.844)	(+)
Log DIST	24.758 (1.68)*	(−)
EUxLogDGDP	24.482 (2.56)*	(+)
EUxLogDIST	−28.228 (−1.93)*	(−)
C	2.90 (0.189)	
M_1	−2.154 [0.031]	
M_2	−0.2078 [0.835]	
Wjs	12.67 [0.049] df = 6	
Sargan	8.26 [1.000] df = 57	
Observations	157	
Parameters	16	
Individuals	24	

Notes: The instrument used for first differences was LogDGDP (2, 10). For levels equations, the instruments used are first differences of LOGIVIIT and LogDIST. The null hypothesis that each coefficient is equal to zero is tested, using two-step robust standard error with the Windmeijer correction for finite samples. T-statistics (heteroskedasticity corrected) are in round brackets. ***/**/* – statistically significant respectively at the 1, 5, and 10 per cent levels. *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). 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 two-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)

Table III.
The estimation results

no problems with the validity of the instruments used. The GMM system estimator is consistent if there is no second-order serial correlation in the residuals (m2 statistic). The dynamic panel data model is valid if the estimator is consistent and the instruments are valid.

The model presents five significant variables: LOGIVIITt-1 LogDGDP, Log DIST, EUxLogDGDP, EUxLogDIST. LogEP is the only variable that is not statistically significant.

As expected, the coefficient of the lagged dependent variable is positive and less than one. So, the past changes in LOGIVIIT values have a significant impact on the current variations in the same index.

These results suggest that the main determinants of vertical intra-industry trade in the automobile components are the different structures of demand (Linder hypothesis) and the distance variable used to proxy the transaction costs. As expected, the variable EUxLogDGDP has a positive coefficient and is statistically significant. The results show that when the difference in per-capita GDP increases, this leads to an increase of the VIIT in the automobile components between Portugal and the European partners. When we consider all countries, the variable LogDGDP is statistically significant, but the effect on the dependent variable is negative. The share of VIIT increases when the differences in per-capita income decrease. This means that outside the EU-27, the Linder's hypothesis for this type of vertical trade (components) applies in a different

way. We may surmise that differences in per-capita GDP also capture other differences between countries (such as differences in location advantages, skilled labour, industrial agglomeration, public infrastructure), which will be reflected in the outsourcing and fragmentation decisions of multinational corporations and in the values of VIIT.

However, we can conclude that the hypothesis that the effect of LogDGDP on VIIT is higher for the European partner-countries is confirmed.

As in Zhan *et al.* (2005), the logarithm of the difference in electric power consumption (EP) has a positive effect on the VIIT variable. The coefficient of this variable is also an elasticity. However, this variable is not statistically significant. As this variable is used as a proxy for relative factor endowments, we cannot say that the Heckcher-Ohlin factor proportions theory explains the Portuguese VIIT in the automobile components sector. Fragmentation of the production in this industry is also a matter of differences in factor endowments and factor proportions. The theory of the fragmentation of the production is linked to the traditional trade theory. It is possible that the use of a different measure for relative factor endowments eliminates the statistical insignificance of this explanatory variable.

EUx LogDIST has a negative coefficient and is statistically significant. This negative coefficient is predicted by the gravitational model. Thus, we can conclude that the effect of distance on VIIT is negative and significant for the trade between Portugal and the EU-27 partners. If we consider all countries, the effect of distance on VIIT remains statistically significant, but the effect changes from negative to positive. This is a result that suggests that the effect of distance on VIIT is different for different partners and regions. The hypothesis that trade costs are mainly not of the iceberg, but of the per-unity type can explain this result. Under this hypothesis, the unit value of trade is determined by the distance between trading partners. Trade costs will lead to price discrimination, which will contribute to differences in prices at home and abroad. More valuable goods will be traded over longer distances. This effect is known as the "shipping the good apples out effect" (see Hillberry and Hummels, 2002; Hummels and Skiba, 2004; Helble, 2007). So, the force of gravity becomes less important and the further away the trading partner is located, the higher is the value of the exports per unit and the higher is the VIIT index. We may also consider that the gravity force is rendered weaker if the countries are not members of an integration area (such as the EU). According to this hypothesis, distance influences not only the trade, but also the composition of trade.

7. Conclusions

In this paper, we have analysed the evolution and main determinants of vertical intra-industry trade (VIIT) in the automobile components sector. In the case of Portugal, there is evidence of the growing importance of the fragmentation of production in the automobile sector, using the VIIT index in car components as a measure of fragmentation. Using a fixed-effects dynamic panel data model, the study confirms that the differences in per-capita income and transaction costs are the main determinants of the fragmentation of production in the automobile components sector. The Linder hypothesis that differences in per-capita incomes can explain intra-industry trade was also found to be statistically significant in explaining the VIIT in car components. Considering the trade between Portugal and the EU-27, the higher the difference in per-capita GDP, the higher will be the fragmentation of

production measured by the VIIT index. The gravity model also contributes very well to explaining the fragmentation of automobile production. The multiplicative dummy variable EUxDistance is statistically significant and the negative coefficient confirms that the transportation cost is an important explanatory variable of trade in components between Portugal and the EU-27. In the Portuguese case, offshore outsourcing, or international fragmentation, in the car industry is negatively affected by the distance between Portugal and other EU-27 countries. However, when we consider the VIIT between Portugal and countries outside the EU-27, the variable distance is statistically significant, but with a positive coefficient. Therefore, the results for this variable (which is a proxy for transport costs) suggest that the VIIT in automobile components is affected in different ways by these costs. To summarise, the results seem to suggest that both the gravitation model and the Linder hypothesis have validity when EU countries are considered (EUxLogDGDP, EUxLogDIST coefficient signs in line with the expected sign), but they stop having validity when EU and non-EU countries are considered (logDGDP, logDIST coefficient signs not in line with the expected signs). These results suggest that the force of economic integration due to the reduction or removal of trade barriers and non-trade barriers between member countries will increase the share of VIIT in the auto components and the fragmentation. In addition, the results suggest that distance influences both trade and the composition of trade, the force of gravity having less impact when the trading partner is further away and is not a member of the integration area. In this case, trade costs are mainly of the per-unity type and the increase of the terms of trade, which is positively correlated with distance, will increase the fragmentation measured by the VIIT index.

The study does not confirm that fragmentation can be explained by the Heckcher-Ohlin theory (HO) – the difference in relative factor endowments and factor proportions used to produce the variety of goods does not explain the VIIT in intermediate products, which in this specific case are automobile components. This merits further investigation using different measures for relative factor endowments.

Offshoring, outsourcing and fragmentation are generally discussed in the context of multinational corporations (MNC) theory and the role of these firms in international trade and globalisation. It is well known that MNCs are always seeking to purchase cheap inputs from abroad. With globalisation, the role of MNCs in international trade is increasing. Offshore outsourcing has grown because these firms have sought to reduce their labour costs. The MNCs are advocates of free trade and, as such, strongly favour outsourcing. However, there are winners and losers from free trade. As income distribution is affected by trade, there is always controversy in relation to outsourcing and fragmentation.

Some empirical studies estimate that 70 per cent of the income gains from outsourcing go to the outsourcing country and the remaining 30 per cent go to the country that carries out the outsourced activity. All trade theorists agree that outsourcing promotes trade. The effects of fragmentation and globalisation on income distribution are a matter of empirical evidence and this topic merits further research. Does Portugal gain from the outsourcing of its car industry? It is to be hoped that eventually, when the economic climate improves, outsourcing may also generate much-needed employment gains for the country. Productivity may increase and the increase of profits can lead to the expansion of the sector. However, this hypothesis must be tested.

Notes

1. Russia and the remaining six EU countries were excluded due to the unavailability of data. In addition, note that Belgium and Luxembourg are treated as one combined economy.
2. Papke and Wooldridge (1996) considered that no special data adjustments are needed for the extreme values of zero and one. Sharma (2002) suggests the logit transformation method.
3. In this paper, the cross-sectional dimension, N, exceeds the time series dimension, T. As N is small (N = 24), we considered using the bias-corrected Kiviet (1995, 1999) estimator. It is well known that the least squares dummy variable (LSDV) estimator for models with a lagged dependent variable (dynamic panel data models) is not consistent for short panels (large N and small T). LSDV is a fixed-effects estimator that only performs well when T is large. The question is: How big should T be? As the dynamic LSDV estimator generates a biased estimate of the coefficients, Kiviet (1995, 1999) proposed the corrected LSDV estimator (LSDVC), which applies when N is only moderately large. However, the implementation of the LSDVC was not easy for unbalanced panels (see Bruno, 2005a). Following Bruno (2005b), Stata, using the command xtlsdvc, provides a bias-corrected least squares dummy variable (LSDV) estimator for dynamic unbalanced panel data models with few individuals and strictly exogenous regressors. Unfortunately, the model we have specified has time-invariant explanatory variables that are discarded when we use the LSDVC estimator. Therefore, we decided to use the GMM-SYS estimator, but correcting the likely downward bias-estimated standard errors using the Windmeijer correction.

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