THE MARGINS OF PORTUGUESE TRADE AND THE EURO

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ISEG/UTL, September 2011
This paper analyzes the cross-sectional and time-series characteristics of Portuguese exports between 1995 and 2002, before and after the introduction of the single European currency – the Euro. The analysis focuses on a set of trade margins, that compose the total value of exports in a given market, including the number of exporting firms, the number of products exported (extensive margin), and the average exports per firm-product pair (intensive margin).

Using an extremely rich and comprehensive international trade data set for Portugal, we show the following results. First, the extensive margin (mainly the number of exporters and the number of exported products) is the main factor explaining the cross-sectional variation of Portuguese exports across trading partners. Second, the evolution over time of all trade margins for the Euro Zone is dominated by a unit root, implying, for example, that shocks affecting the number of exporters, the number of exported products or the average exports per firm-product pair will have permanent effects. Third, we identify three potential effects of the introduction of the Euro in 1999: (i) a positive effect on the number of exporting firms in the four years before the introduction; (ii) a positive effect on the intensive margin, i.e. average exports per firm-product pair, from 1998 until 2002, and (iii) a tendency for firms to homogenize the set of products exported to different destinations, from 1999 to 2002.
RESUMO

Por Wilson M. Araújo

Este artigo analisa as características seccionais e temporais das exportações Portuguesas entre 1995 e 2002, antes e depois da introdução da moeda única europeia - o Euro. A análise baseia-se num conjunto de margens de comércio, que compõem o valor total das exportações num dado mercado, incluindo o número de empresas exportadoras, o número de produtos exportados (margem extensiva), e as exportações médias por combinação empresa-produto (margem intensiva).

Usando uma base de dados de comércio internacional para Portugal, extremamente rica e extensiva, demonstramos os seguintes resultados. Em primeiro lugar, a margem extensiva (principalmente o número de exportadores e o número de produtos exportados) é o principal factor que explica a variação seccional das exportações Portuguesas entre os parceiros comerciais. Em segundo lugar, a evolução ao longo do tempo de todas as margens de comércio para a Zona Euro é dominada por uma raiz unitária, implicando, por exemplo, que os choques que afectam o número de exportadores, o número de produtos exportados ou as exportações médias por combinação empresa-produto terão efeitos permanentes. Em terceiro lugar, identificamos três possíveis efeitos da introdução do Euro em 1999: (i) um efeito positivo sobre o número de empresas exportadoras nos quatro anos anteriores à introdução, (ii) um efeito positivo na margem intensiva, i.e., exportações médias por combinação empresa-produto, de 1998 até 2002, e (iii)
uma tendência para as empresas homogeneizarem o conjunto de produtos exportados para diferentes destinos, de 1999 a 2002.
ACKNOWLEDGMENTS

I would like to thank the economists of the Research Department of the Bank of Portugal, and especially my advisor Luca David Opromolla for their very important suggestions, continuing support and motivation. I also would like to thank Mário Centeno for his comprehension, and Paulo Rodrigues for his help in opening up new research paths.

I could not forget my family as well. They were always by my side in the good and the bad moments. I am very grateful to them.

Last but not least, a great thank you to Cláudia Barradas who worked with me at the beginning of this long journey.

Thanks to you all.

Wilson M. Araújo
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1. INTRODUCTION

The great majority of the recent theoretical and empirical contributions to the economics literature on international trade have been characterized by an increasing attention to the role played by firms. The decision of entering or exiting a foreign market, the decision of which products to export, and the actual sales per firm-product are problems and outcomes that have gone under more and more intense scrutiny. In other words, the division of trade into an intensive and an extensive margin has become standard and it is justified by the fact that not only the “intensity with which firms trade” matters, but also “how they trade”. The analysis of trade margins helps explaining the evolution of aggregate trade flows between countries, and understanding how aggregate trade flows respond to external shocks.

One of the most important economic events in history occurred in 1999 with the introduction of the Euro in eleven European countries. The introduction of a single currency was expected to reduce the (variable and fixed) costs of trade, and allow individuals and businesses to make exchanges that were previously unprofitable. Therefore, the Euro was expected to promote welfare through the facilitation of trade within the Euro Area.

Despite the fact that more than ten years have passed since the introduction of the Euro and the existence of several studies on its impacts on trade, the lack of country-specific evidence on trade margins is still considerable. This paper fills

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1 Specifically, Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain. Greece joined in 2001.
this gap by decomposing Portuguese aggregate exports into trade margins and studying their characteristics before and after the introduction of the Euro.

Using an extremely rich and extensive international trade data set for Portugal, this paper analyzes the exports margins between 1995 and 2002. Portuguese aggregate exports to a given destination are decomposed into four components, as in Bernard et al. (2009): the number of exporting firms, the number of products exported, the average exports per firm-product, and a residual term (the density) capturing the degree of homogeneity in the set of products exported across destinations. The intensive margin is captured by the third term, while the extensive margin is composed by the other three terms.

Employing the above decomposition, we make three main contributions to the literature. First, we take a cross-sectional approach and quantify the importance of each margin in explaining the variation of exports across Euro Zone and non-Euro Zone trading partners. Second, we adopt a time-series approach and test for the presence of a unit root in each of the four trade margins. This allows us to identify whether the evolution of the trade margins for the Euro Zone is well described by a stationary or by a unit-root process. An important aspect of our analysis is that it employs a unit-root test that allows for the presence of an unknown number of nonlinear breaks in the deterministic component of each trade margins series. Finally, we provide some initial evidence on the causal impact of the introduction of the Euro on trade margins. To this end, we estimate two gravity-like equations for each margin. In the first specification, we adopt a
difference-in-differences approach, while in the second we allow for time varying
treatment effects.

Several results emerge from the analysis. First, we find that variation in
exports across trading partners is mainly governed by the extensive margin.
Second, unit-root tests suggest the existence of a unit root in all margins series.
Third, using a difference-in-differences approach we estimate a positive
instantaneous impact of the Euro on the density and on the average exports, a
negative impact on the number of products exported, and no significant effect on
the number of exporting firms. When allowing for time-varying treatment effects,
we estimate significant positive effects (i) on the number of exporting firms in the
four years preceding the actual introduction of the Euro, and (ii) on both average
exports per firm-product and density in the four years following the introduction
of the Euro.

The remainder of the paper is organized as follows. Section 2 provides a
short review of the relevant literature, while Section 3 describes the data used in
the empirical investigation. Sections 4 and 5 present the empirical methodology
and the results, respectively, and Section 6 concludes.

2. SHORT REVIEW OF THE RELEVANT LITERATURE

The study of trade margins plays a key role in international trade. The
possibility of dissecting trade data along the firm, product, and country
dimensions has allowed researchers to gain important insights in understanding
the determinants of trade flows and the gains from opening trade. It is now
customary to talk about extensive and intensive margins of trade. The extensive margin is the one that has undergone several changes in its composition. Initially, the study of the extensive margin only contemplated the product margin, such as the goods specialization, but over the years, more particularly after the nineties, the firm margin began to conquer its space so that recent investigation in international trade consider it now fundamental for understanding general patterns of trade. While the first models mentioning firms, such as Krugman (1980) considered that either all or no firms took part in trade, more recent models like Melitz (2003) consider that firms are heterogeneous, though mono-product exporters. To overcome this weakness of heterogeneous-firm models, some modifications have been introduced, in which firms are allowed to export more than a single product on each market. Trade models as those in Bernard et al. (2006) or Eckel & Neary (2006) encompass this assumption. As a consequence, these last developments legitimated the emergence of new extensive margins as the number of products exported per firm and the number of firm-product combinations exported to a given destination.

In spite of the recent advances in the theory of international trade, there are only few studies that analyse the impact of the adoption of the Euro on intra-European trade taking advantage of firm-level or more disaggregated data sets. Baldwin & Nino (2006) and Flam & Nordström (2006) use a bilateral trade data set at the product-level and find evidence that the effects of the Euro on trade manifest themselves mainly through the variation in the number of product exported within the Euro Zone. In order to identify firm-level effects of the
adoption of the Euro, Berthou & Fontagné (2008) makes use of French firm-level export data and a business survey to conclude that there is a positive impact of the Euro on firms’ decisions to export, on the number of products exported and on the export value per product, for larger and more productive manufacturing firms. Baldwin et al. (2008) uses the same kind of firm-level data for Belgium, France and Hungary. They compute a set of descriptive statistics that show an increase in the number of products exported by French firms to Euro Zone countries in 1999, compared to other destinations. Analogous conclusions were drawn from the number of destinations per product per firm for Belgian and French cases.

3. DATA

This section describes the data used in the empirical investigation. In addition, the last subsection provides a brief analysis of the evolution of Portuguese exports over time.

3.1. Trade Data

The trade data set employed in this thesis was provided by Statistics Portugal (Instituto Nacional de Estatística – INE). It contains information on all export and import transactions made by Portuguese mainland-based firms during the period from 1995 to 2005. Each data point includes information on the year and month of the transaction, the firm’s identifier, the product code (an eight-digit Combined Nomenclature), the destination or origin country, the quantity
transacted (in kilos), the (nominal) value of the transaction in Euros, the transport mode, the relevant international commercial term (CIF, FOB, etc.) among others.²

One of the most important features of this data set is that it allows drawing information on how many firms and products are involved in trade relationships with a given country at any moment in time. The sample used in this study covers the period 1995-2002 and 27 destinations.

The reasons behind the choice of the time horizon, 1995-2002, are the following: avoiding complications related to the EU enlargement in 2004 and studying the evolution of exports in a period that covers the 4 years immediately preceding and following the introduction of the Euro. Destinations are divided into two groups: nine Euro Zone countries, that compose the treatment group in the difference-in-difference analysis, and 18 OECD (Organization for Economic Co-operation and Development) non-Euro Zone countries, that represent the control group in the difference-in-difference analysis.³ Table I in Appendix B reports the countries used in the empirical investigation, distinguishing them by Euro Zone (9 countries) and non-Euro Zone (18 countries).⁴

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² The Combined Nomenclature (CN) is a system that defines the general rules for the classification of commodities, imported into or exported from the European Union, to an eight-digit code and is adjusted on a yearly basis. This system is composed of the Harmonized System (HS) with additional European Community subdivisions: the first six digits of the CN roughly coincide with the HS classification. The HS classification is run by the World Customs Organization and is widely used in international trade relationships.

³ Note that these 27 destinations represent about 91% of Portuguese exports over the period 1995-2002.

⁴ Greece was excluded to avoid potential problems in controlling for its entry in the Euro Zone only in 2001, while Belgium and Luxembourg are considered as a single country ("Belux").
3.2. Other Data Sources

In order to enrich the econometric analysis in the difference-in-differences approach, the respective estimations also include the real GDP of the destination and the bilateral real exchange rate as covariates. Information on (real and nominal) gross domestic product and bilateral nominal exchange rates were obtained from OECD and Bank of Portugal websites, respectively. With this information, the bilateral real exchange rates were constructed based on the GDP deflators, in Euros.

3.3. A First Glance to Portuguese Exports

An initial analysis on Portuguese exports and some of their components helps to identify different behaviour patterns, before and after the introduction of the Euro and between Euro Zone and non-Euro Zone.

Table II in Appendix B shows some descriptive statistics of Portuguese exports, in 1999. The numbers indicate that Portugal was more active, in all respects, within the Euro Zone than outside in the year when the Euro was introduced. This pattern is to be expected if we think that the Euro considerably reduced trade costs within the Euro Zone. However, as we will see below, the evolution of these indicators over time makes this interpretation less straightforward.

Figure 1 in Appendix A displays the evolution of the annual series: export value, number of exporting firms, number of product categories exported and number of shipments to Euro Zone and non-Euro Zone countries over the period

Three main patterns stand out from Table III: (i) the series on the value of exports is the one showing the highest growth rates (for the two destinations and periods considered); (ii) all series except the one on products present superior growth rates in the pre-Euro period than in the post-Euro period; (iii) with the exception of the exports value, all post-Euro growth rates are considerably higher for non-Euro Zone series than for Euro Zone series.

In view of this, apparently there are reasons to argue against the possible trade creation from Euro introduction: growth rates are higher in pre-Euro period than the post-Euro period with the single exception of the products exported. However, it must be clear that from this preliminary analysis it is not possible to see specific-country evolution (we only see two groups of countries viewed each one as a single destination) and that might mitigate potential Euro effects at destination country level. In addition, we need to control for other factors that may influence trade to estimate, if present, the Euro effects.

4. EMPIRICAL METHODOLOGY

This section provides the econometric methodology applied in the empirical investigation and that is based in a decomposition of Portuguese exports into four trade margins.
4.1. Decomposing Aggregate Exports into Extensive and Intensive Margins

As discussed above, the analysis focuses on four components of the value of Portuguese exports to a given destination. Following Bernard et al. (2009), Portuguese exports to destination $i$ ($x_t^i$) can be decomposed into the product of the number of firms exporting to that destination ($f_i$), the number of product categories exported to the destination ($p_i$), the density of trade ($d_i$) (to be defined below), and the average value of exports per firm-product ($x_i$),

$$ x_t^i = f_i p_i d_i x_i, $$

where $d_i = o_i / (f_i p_i)$, $o_i$ is the number of firm-product pairs for which exports to destination $i$ are positive and $x_i = x_t^i / o_i$. In this decomposition the extensive margin is captured by the first three margins ($f_i$, $p_i$ and $d_i$), while the intensive margin is present through the last term $x_i$. It is important to include the density term in order to adjust for the fact that not all firms trade all products. If firms tend to export a constant set of product categories, Bernard et al. (2009) alert that density is negatively correlated with the number of exporting firms and products exported:

As the number of firms and products grows across countries, the number of possible firm-product observations ($f_i p_i$) expands multiplicatively. If firms are active in a relatively constant subset of products across countries, the actual number of firm-
product observations with positive trade will expand less than proportionately, causing density to decline.

In Bernard et al. (2009), p. 4.

Next subsections include the econometric methodology adopted in this paper in order to concretize the empirical investigation.

4.2. Cross-Sectional Variation in Total Exports

Whether the extensive or the intensive margin contributes most to differences in exports across trading partners is a question that recently gained considerable attention in the international trade literature. In this section, we describe the methodology used to analyze the contribution of each margin to explain the differences in Portuguese exports across trading partners for a given year.

The methodology that we adopt was introduced in Bernard et al. (2009). Using the decomposition of Portuguese exports in equation (1) we regress the logarithm of each margin (firms, products, density, and average exports) on a constant and on the logarithm of total exports using ordinary least squares. Let \( y_i \) represents one of the four trade margins to destination \( i \), i.e., \( y_i \in \{ f, p, d, x \} \), then the four regressions to be estimated for each year are:

\[
\ln(y_i) = c_y + \beta_y \ln(x_t) + u_{y,i}, \quad i = 1, 2, \ldots, n,
\]
where \( u_{y,i} \) is the error term when the dependent variable is the logarithm of the trade margin \( y \), \( c_y \) is a constant and \( \beta_y \) is the parameter of interest and represents the share of the whole variation in exports explained by margin \( y \). Noting that the decomposition in (1) is log-linear and knowing that OLS is a linear estimator with zero mean residuals, the sum of the estimated coefficients \( \hat{\beta}_y \) from the four equations is equal to unity, i.e., \( \hat{\beta}_f + \hat{\beta}_p + \hat{\beta}_d + \hat{\beta}_s = 1 \). Finally, in order to find differences in margins’ contributions across trading partners, the four regressions are estimated for three different groups of destination countries: OECD countries (\( n = 27 \)) and within OECD, Euro Zone countries (\( n = 9 \)) and non-Euro Zone countries (\( n = 18 \)).

### 4.3. Trade Margins over Time

This part assesses the evolution of the trade margins over time. After a small introduction about the distinction between stationary and unit-root processes, we describe the methodology used to test for the presence of a unit root in the trade margins time series.

#### 4.3.1. Stationary or Unit-Root Processes and Trade Margins

Amongst several important subjects around macroeconomics, the evolution of economic series over time when these display an increasing trend (such as exports) remains a striking object of study. An important question that continues to deserve a lot of attention in this respect is to know whether a time series is

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\(^5\) First section of Appendix C demonstrates this result.
stationary or not. In other words, are series better approximated by a $I(0)$ or a $I(1)$ process? The answer to this question is of particular interest because the understanding of how exports behave over time has huge implications on the role of the economic policy. If the series is $I(1)$ (contains a unit root), then the shocks affecting the series will have permanent effects on the series level and policy action is required to return series to its original level. On the other hand, if the series is $I(0)$, the shocks affecting the series will purely be transitory, and, in this case, the need for policy action is less obligatory because the series will eventually return to its equilibrium level.

Once trade margins and the introduction of the Euro are central in this study, we test for the presence of a unit root on Portuguese trade margins series for the Euro Zone. To make possible the application of these tests, the trade margins time series were constructed from equation (1) on a monthly basis (between 1995 and 2002) and considering Euro Zone as a single destination. Figure 2 in Appendix A shows the evolution over the period 1995-2002 of the respective monthly trade margins series. As we can see, all series display seasonality and an increasing trend over time, except density which exhibits a decreasing trend. A decreasing trend for the density series is to be expected since, as explained above, density is negatively correlated with the number of firms and products, both increasing over time.

Below we present the methodology used to check for non-stationarity of the trade margins time-series. Our methodology is based on the well-known Dickey-Fuller (DF onwards) test for the presence of a unit root. However, an important
modification on its usual specification is introduced in order to safeguard results when there are potential structural breaks in series as those related to the introduction of the Euro. If the presence of a unit root is not rejected the series seems well approximated by a $I(1)$ process, while a $I(0)$ process seems more adequate when the presence of a unit root is rejected.

4.3.2. Unit-Root Test on Trade Margins

The traditional DF tests are very popular amongst unit-root tests. However, since Perron’s (1989) seminal paper, it is known that ignoring the existence of structural breaks in a series has very problematic consequences for these tests, mainly the loss of power and size distortion. An alternative method to consider breaks that was initially proposed was to approximate the breaks using dummy variables. This method turned out to have several drawbacks: (i) it is necessary to know the exact number and location of the breaks which are almost always unknown; (ii) the tests accounted only for one or two breaks, which is very restrictive; (iii) the use of dummy variables suggests sharp changes in the trend or level; since breaks in economic series often gradually display their impacts over time, dummies will not capture well this behaviour. The latter drawback is particularly relevant in the context of this study since it is likely that the introduction of the Euro displayed its effects only gradually over time. Recent developments in unit-root tests allow us to overcome the above difficulties. Below, we will test for a unit root in the presence of structural breaks using an adapted version of the DF test proposed by Enders & Lee (2009). This test works
equally well, i.e. it has good size and power properties, both in the presence of gradual and sharp breaks.

Enders & Lee (2009) modifies the usual DF test implementing a variant of the Flexible Fourier transform (see Gallant (1981)) to control for the unknown nature of the breaks. A Fourier adjustment, using only a small number of low frequency components, is able to capture the types of breaks that we usually see in economic data. We take this approach to account for breaks because it is reasonable to think that the effects of the introduction of the Euro were spread out over time and did not fully manifest themselves in 1999. Therefore, the usual DF specification will also include a time-dependent deterministic term $\alpha(t)$:

$$y_t = \alpha(t) + \gamma t + \delta y_{t-1} + \epsilon_t,$$

where $\alpha(t)$ can be written as:

$$\alpha(t) = \alpha_0 + \sum_{k=1}^{n} \alpha_k \sin\left(\frac{2\pi kt}{T}\right) + \sum_{k=1}^{n} \beta_k \cos\left(\frac{2\pi kt}{T}\right), \quad n \leq T / 2.$$

In the above formulation ((3) and (4) altogether), $\epsilon_t$ is a stationary error term with variance $\sigma^2$, $n$ is the total number of frequencies contained in the Fourier adjustment, $k$ is a particular frequency and $T$ is the number of observations. Following Enders & Lee (2009) that a single frequency $k$ can capture an ample variety of breaks that we see in economic data, the resulting equation, from (3) and (4), is:

$$y_t = \mu + \alpha \sin\left(\frac{2\pi kt}{T}\right) + \beta \cos\left(\frac{2\pi kt}{T}\right) + \eta t + \delta y_{t-1} + \epsilon_t,$$
or equivalently:

\[
\Delta y_t = \mu + \alpha \sin(2\pi k_i t / T) + \beta \cos(2\pi k_i t / T) + \eta t + \phi y_{t-1} + e_t,
\]

where \(y_{t-1}\) was subtracted on both sides of (5) such that \(\phi \equiv \theta - 1\). This last expression (6) is very useful since it allows testing for a unit root directly from the \(t\)-ratio of \(\phi\). As residuals might display serial correlation, (6) is augmented with lagged values of \(\Delta y_t\):

\[
\Delta y_t = b_0 + b_1 \sin(2\pi k_i t / T) + b_2 \cos(2\pi k_i t / T) + b_3 t + \rho y_{t-1} + \sum_{j=1}^{l} \lambda_j \Delta y_{t-j} + u_t.
\]

In order to determine the lag length \(l\) we follow the GTS \(t\)-sig strategy, consisting of a \(t\)-test at 10% significance level on the last augmented term until reject the null of \(\lambda_l = 0\). At the same time, when it is possible to eliminate the last lag, serial correlation tests on residuals are implemented to verify if the elimination of the last augmented term caused serial correlation; if it did, then the term is not excluded and that is the equation test for a unit root. To choose the maximum of \(l\) to start with, it is used the \(l_{1/2}\) rule present in Schwert (1989):

\[l_{\text{max}}(T) = \left\lfloor 12.12 \cdot (T / 100)^{1/4} \right\rfloor,\]

where \(\lfloor \cdot \rfloor\) represents “the integer part of”. But, since this rule is not suited to maximize the power of the test, it is used a “smoothed” version: as the total number of observations of margins series is \(T = 96\), according to \(l_{1/2}\) rule the \(l_{\text{max}}\) is 11; then it is set \(l_{\text{max}} = 10\).

---

\(^6\) GTS \(t\)-sig stands for “general-to-specific sequential \(t\)-sig”.

\(^7\) Here, the Breusch-Godfrey’s serial correlation LM test is used to test serial correlation on residuals up to order 6 and 12, BG(6) and BG(12), respectively.
Finally, the hypothesis test for a unit root is simply:

\[(8) \quad H_0: \rho = 0 \quad \text{vs} \quad H_1: \rho < 0\]

on (7) using \(t_{DF} = \hat{\rho} / se(\hat{\rho})\). The critical values for this test are reported in Enders & Lee (2009).

However, as we have seen, this method depends on the value of the frequency \(k\), and because this is generally unknown, it needs to be estimated in first place. A grid-search procedure that consistently estimates \(k\) is to estimate equation (6) for each integer \(k = 1, 2, ..., 5\). \(\hat{k}\) results from the regression with the smallest “Sum Squared of Residuals” (SSR). As such, the unit-root test is applied on (7) with \(\hat{k}\).

Now, we already know how to proceed in the case of a structural break on a series. And what if there is no need to account for structural breaks? In this case, Enders & Lee (2009) recommend performing the usual linear DF test without the trigonometric terms because it will have more power. As we clearly see, the “standard” DF test emerges as a special case of (6) making \(\alpha = \beta = 0\). Enders & Lee (2009) also developed an \(F\)-test for the null \(\alpha = \beta = 0\), using the following \(F\)-statistic:

\[(9) \quad F(k) = \frac{(SSR_0 - SSR_s(k)) / 2}{SSR_s(k) / (T - q)},\]

where \(SSR_s(k)\) is the SSR from (6), \(SSR_0\) is the SSR from the regression without the trigonometric terms, \(q\) is the number of regressors and \(T\) is the total number of
observations. But, since \( k \) needs to be estimated, they consider the following modification of the \( F \)-test in (9):

\[
F(\hat{k}) = \max_k F(k),
\]

where \( \hat{k} = \arg\max_k F(k) \). As it is evident, the \( \hat{k} \) giving the smallest SSR value will maximize the \( F \)-statistic in (9) such that \( \hat{k} = \arg\inf_k \SSR_k \). They report the critical values for this test in their paper. If the sample value of \( F(\hat{k}) \) is larger than the respective critical value, the test for a unit root uses equation (7) with the trigonometric terms. On the contrary, if the null is not rejected, then it is possible to augment power by using the usual linear DF test (equation (7) without the trigonometric terms).

Below, we summarize in three steps the methodology presented in this part and that is applied on Portuguese trade margins series for the Euro Zone. As series were collected monthly and they display seasonality, all regressions mentioned below also include the usual eleven monthly dummies to account for it. Therefore, considering \( y_t \) as a trade margin, the procedure is as follows:

Step 1: Estimate (6) for integer values of \( k \) from 1 to 5. \( \hat{k} \) results from the regression with the smallest SSR.

Step 2: Perform the \( F \)-test for a break \( (\alpha = \beta = 0) \) on equation (6) with \( \hat{k} \), using (9). If the null \( \alpha = \beta = 0 \) is rejected, use (7) to test for a unit root. If the null is not rejected use (7) without the trigonometric terms (linear DF test).
Step 3: Test for a unit root using (7) with or without the trigonometric terms. In any case, the hypothesis test for a unit root is the same described in (8), $H_0 : \rho = 0$ vs $H_1 : \rho < 0$. If $H_0$ is not rejected, we do not reject the existence of a unit root and then, the margin series seems well approximated by a $I(1)$ process. On the contrary, the rejection of $H_0$ implies the rejection of a unit root and thus, a $I(0)$ process will approximate better the series.

To see how well a Fourier approximation mimics the time path of the margins series, Figure 3 in Appendix A shows the seasonally adjusted margins series along with the nonlinear trend Fourier adjustment (dashed lines) obtained by estimating the regression $y_t = c_0 + c_1 \sin(2\pi \hat{k} t / T) + c_2 \cos(2\pi \hat{k} t / T) + c_3 t + \nu_t$, where $\hat{k}$ results from “Step 1” above. As we can see by the dashed lines, each series seems particularly well approximated, though this adjustment is not always necessary.

4.4. Euro Effects on Trade Margins

In this part, we describe the methodology used to identify the impact of the Euro on Portuguese trade margins. Did the Euro raise the number of Portuguese exporting firms and the product categories exported? How did export value per firm-product respond to the introduction of the Euro? These kinds of questions are central when analyzing currency union effects on trade margins. To explore them for the Portuguese case, we use a balanced annual panel dataset from 1995 to 2002, in which 27 destination countries compose the cross-section dimension, and
we apply a difference-in-differences approach to estimate the Euro effects on the four Portuguese trade margins.

The difference-in-differences technique measures the effect of a treatment at a given period in time. The reasoning of this technique consists of examining the effect of some kind of treatment by comparing the treatment group after treatment both to the treatment group before treatment and to a control group. Though its weakness is to incorrectly identify the treatment effect when something else occurs between the two groups at the same time as treatment, this method is simple to implement and under certain assumptions is also a strong econometric tool to evaluate the effects of an important policy. In this study, the treatment group is composed of the countries that entered the Euro Zone in January 1999 (9 destinations) while the control group is composed of the countries that never entered the Euro Zone (18 destinations). According to this methodology, the key assumptions that permit to identify the effect of the introduction of the Euro on the trade margins are two: (i) the introduction of the Euro produced a constant instantaneous effect; (ii) exports to Euro Zone and non-Euro Zone countries would evolve by the same way in the absence of Euro.

Letting $y_{it}$ be a trade margin to a given destination country $i$ at time $t$, $y_{it} \in \{f_{it}, p_{it}, d_{it}, x_{it} \}$, the Euro effects on each trade margin are estimated using the fixed effects Poisson estimator, with robust standard errors clustered by destination country, on the following gravity equation:

---

8 See Table I in Appendix B to remind countries.
\[ y_{it} = \exp(\alpha_{it} + \alpha_{it}' EZ_{it} + \alpha_{it}' \ln(rgdp_{it}) + \alpha_{it}' \ln(rer_{it}) + \alpha_{it}' \kappa_{i} + \alpha_{it}' \kappa_{t})e_{it}^\varepsilon. \]

\(EZ_{it}\), the variable of interest inherent with the difference-in-differences method, is a dummy variable equal to one over the period 1999-2002 when the destination country is a member of the Euro Zone, and zero otherwise. \(\ln(rgdp_{it})\) is the natural logarithm of the destination’s real gross domestic product. \(\ln(rer_{it})\) is the natural logarithm of the real exchange rate. \(\kappa_{i}\) and \(\kappa_{t}\) are the sets of 26 destination and 7 year dummies, respectively, in order to get a fixed effects estimator to deal with the unobserved heterogeneity. The reason behind the use of the Poisson estimator is related to the gravity equation generally applied in international trade area. In this respect, Silva & Tenreyro (2005) argue that taking the logs in a gravity equation, as in (11), and apply OLS in the presence of heteroskedasticity leads to biased and inconsistent estimates because, in this case, we would get \(E[\ln(e_{it}^\varepsilon) | x_{it}] \neq 0\), since “the expected value of the logarithm of a random variable depends both on its mean and the higher-order moments of the distribution”. As an alternative, Silva & Tenreyro (2005) suggest applying directly the Poisson maximum likelihood estimator on (11), where the key assumption that provides unbiased and consistent estimates of the parameters is that the regressors are strongly exogenous. Second section of the Appendix C shows this fact.

The traditional gravity models make use of cross-section data on different pairs of trading partners and include both exporter and importer GDP in the regression. But, as Bernard et al. (2007) point out, when it is used data from a
single exporting country (in this case Portugal), “exporter income is captured in the regression constant and only importer income is included in the regression.”

In spite of the difference-in-differences specification in (11) is the usual method to estimate treatment effects, in this particular case of the Euro seems to be more adequate to assume that the Euro produced effects even before its introduction, so that firms started to adjust their trade in a proactivity perspective, and that these effects may vary over time. Accordingly, if the Euro effects are spread out over years, then a constant instantaneous effect of the Euro may be misspecified. To hold this, and following Laporte & Windmeijer (2005), we introduce some flexibility on the analysis by substituting the dummy step variable, $EZ_{it}$, by annual pulse variables from 1996 to 2002 in (11):

$$
(y_{it} = \exp(\gamma_0 + \gamma_1EZ_{96it} + ... + \gamma_7EZ_{02it}) + \gamma_8\ln(rgdp_{it}) + \gamma_9\ln(rer_{it}) + \gamma_{10} + ... + \gamma_{11} + \gamma_{11}(k_{it}) + v_{it}^{\gamma})
$$

where the pulse variable $EZ_{96it}$ is equal to one in 1996 when the destination country belongs (or in this case, will belong) to Euro Zone and so on for the remain pulse variables ($EZ_{97it}$, $EZ_{98it}$, $EZ_{99it}$, $EZ_{00it}$, $EZ_{01it}$ and $EZ_{02it}$). Therefore, the coefficient associated with a given pulse variable represents the Euro effect in that year (indicated by dummy) on trade margin $y_i$. 

5. EMPIRICAL RESULTS

This section exposes the main results obtained from the methodology described in previous section. The titles in this section match to the titles in the respective methodology section for easier linking “methodology-results”.

5.1. Cross-Sectional Variation in Total Exports

The contribution of trade margins (firms, products, density, and average exports) to cross-sectional variation in Portuguese exports across trading partners in a given year is obtained by the estimation of the equation (2) using OLS. The results are displayed in Table IV in Appendix B in which is only reported the estimate of the slope parameters $\beta_y$. Once the main conclusions do not change over years, here it will be discussed the results for 2002 (last part of the table). Each cell corresponds to a different regression based on equation (2) according to the margin in study and displays the estimated slope coefficient and standard error (in parentheses) of that regression at a given year. Thus, each column within a given year sum to unity. In 2002 (last portion of the table), as we can see in the last element of the column “OECD”, the intensive margin (given by the average firm-product exports) explains, on average, about 41% of the variation in Portuguese exports across OECD destinations. Variation in the number of exporting firms (first element) and the number of products exported (second element) account for 50.6% and 41.8% of the variation, respectively. The coefficient for density is negative (-0.332), revealing the negative correlation with firms, products and aggregate Portuguese exports. Nevertheless, the overall
extensive margin accounts for 59.1% of the variation (more than intensive margin).\(^9\) Similar conclusion is extracted for the other two sets of countries in which OECD is divided: extensive margin accounts for the vast majority of the variation of Portuguese exports to Euro Zone and non-Euro Zone (56.8% and 64.0%, respectively). Besides that, we can also see that the extensive margin is even more important for non-Euro Zone than Euro Zone destinations. So, it follows that the extensive margin is the largest contributor to variation of Portuguese exports across different destinations, but it is less important to explain variations of Portuguese exports to Euro Zone countries than to non-Euro Zone countries. The results do not differ substantially for the other years. Thus, previous finding alert for the fact that the analysis of Portuguese exports must take into account not only knowledge on the value exported, but also a very deep knowledge on exporting firms and products exported.

5.2. Unit-Root Test on Trade Margins

This subsection reports the results from the unit-root tests applied on Portuguese trade margins series for the Euro Zone. Margins series are observed monthly from 1995 to 2002 (Figure 2 in Appendix A). We follow the three steps presented in the methodology section above for taking into account potential smooth breaks in series, caused by the introduction of the Euro.

As mentioned before, given we are in the presence of monthly series, we must keep in mind that all regressions involved in calculations, and that will be

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\(^9\) This extensive margin’s contribution is given by the sum of the three first terms of the column “OECD” for the year 2002 of Table IV in Appendix B.
cited below, additionally include eleven monthly dummies to control for seasonality.

The first step consists on finding the best frequency $k$. This is done by estimating (6), for the integers $1 \leq k \leq 5$, choosing $\hat{k}$ (the estimated frequency) from the estimation yielding the lowest “Sum of Squared Residuals”. First portion (a) of Table V in Appendix B indicates in last column that the best frequency is one for firms and density, two for products and three for average firm-product exports.

In the second step, it is applied an $F$-test for a break to verify whether the sine and cosine terms will be needed in the DF equation test for a unit root. At this stage, it is estimated (6) (where $k$ is replaced by $\hat{k}$) with and without the trigonometric terms. Then, it is computed the $F$-statistic as in (9) and (10), and implemented the test for the null of joint nullity of the two parameters associated with the sine and cosine terms ($\alpha = \beta = 0$). The test is performed at 5% significance level and the critical value is reported in Enders & Lee (2009). The last column of the middle portion (b) of Table V in Appendix B shows that the trigonometric terms are needed in the test equation for firms, but not in the equations for the other margins (products, density and average exports). For the latters we will use the usual linear DF test since the $F$-test did not reject the inexistence of any break in these series.

Finally, in third and last step is performed the unit-root test on each margin using (7) with $\hat{k}$ and after choosing the appropriate lag length $l$. As we have just
seen by the previous $F$-test, the DF equation test with the trigonometric terms will be applied on firms’ series while the usual linear DF test on the other three series: products, density and average exports. The test is performed at 5% significance level and the critical value for the nonlinear DF test is reported in Enders & Lee (2009). The last portion (c) of Table V in Appendix B shows the results for the unit-root test based on equation (7). The GTS $t$-sig strategy complemented with serial correlation tests on residuals set nine lags for firms, products and average exports and only one for density. As we can observe, all the $t$-statistics of $\rho (\tau_{DF})$ are higher than the critical values reported in the last column. Therefore, the test suggests that all series contain a unit root in their data generating process, once is not possible to reject the null of unit root for all cases. Under this situation, it follows that all Portuguese trade margins for the Euro Zone are well described by a $I(1)$ process and, thus, exhibit great persistence with a stochastic trend (unit root). Having said that, it is expected that all fluctuations in margins represent permanent shifts in trend and, moreover, macroeconomic shocks have a permanent or long-run effect on series level.

5.3. Euro Effects on Trade Margins

The results concerning the effect of the introduction of the Euro on the Portuguese trade margins are the subject of this last section. First, we assume that the effect of the Euro is instantaneous and constant over time by estimating equation (11) with the fixed effects Poisson estimator. Table VI in Appendix B reports a clearly distinct effect of the Euro on the different trade margins. Each
column represents a separate regression according to the trade margin used as the dependent variable. Looking at the first row, we can see that the Euro had no significant effect only on the number of exporting firms \( (f_d) \). Concerning the number of products exported, we estimate a negative impact of the introduction of the Euro, but not as strong as the positive effects found for the density and average exports margins. These last two margins were particularly influenced by the introduction of the Euro.

The previous results are based on a very restrictive assumption, namely that the Euro is expected to produce constant effects over time and only after its actual introduction. The validity of this assumption is very questionable, particularly because nothing prevents economic agents, such as firms, to pre-react to announced external shocks. Indeed, it is very likely that firms tend to pre-adjust their exports in order to maximize their benefits from a shock with high magnitude, such as the introduction of the Euro in the monetary system.

The design of the equation (12) takes the above issues into account. This specification allows for time varying treatment effects before and after the introduction of the Euro. The results are now presented in Table VII of the Appendix B. Two main aspects emerge from the analysis. First, the number of firms exporting to Euro Zone countries increases in the four years prior to the actual introduction of the Euro. Second, both average exports per firm-product and the density terms increase in the four years including and following the introduction of the Euro.
Firms operate under significantly uncertain conditions, constantly making decisions affecting their costs and productivity. A major source of uncertainty arises from trade policy, as documented in Handley & Limão (2011). The increase in the number of firms exporting to Euro Zone destinations, before the actual introduction of the Euro, reveals an anticipation strategy by firms to create new business opportunities and to solidify them during that period. However, firms opted by doing a smooth transition to the new economic reality, as evidenced by the significant rise of average exports only near Euro introduction. This transition culminated in the firms’ specialization in more profitable products (reduction of categories exported), required by the new competition triggered by the “almost” free trading within Euro Zone after 1999.

6. CONCLUSIONS

The distinction between the extensive and the intensive margins of trade has recently become central in the field of international trade for understanding the cross-sectional and time-series determinants of trade, as well as the response of trade flows to important economic and political events. This paper deals with the above three issues using detailed information on export transactions conducted by all firms based in Portugal, over the period 1995-2002.

Results concerning the variation of trade across destination countries show that these differences are due, in large part, to the extensive margin (the number of exporting firms, the number of products exported and density) rather than the intensive margin (average firm-product exports).
We also show that the evolution over time of all trade margins is characterized by a unit-root. Macroeconomic shocks are therefore expected to have a permanent effect on the level of trade.

Finally, the last results identify, after 1999, a negative effect of the introduction of the Euro on the number of products exported, a positive effect on the density and on the average exports and no significant effect on the number of exporting firms. Alternatively, if it is assumed that Euro generated effects also before its introduction, results point out for a positive adjustment on the number of exporting firms until 1999. The number of products exported display the full negative impact three years after Euro introduction, in 2002. Density and average firm-product exports are positively affected by the Euro from 1999 and 1998 onwards, respectively.

This paper is a first attempt in studying the behavior of Portuguese trade margins in response to important external shocks such as the introduction of the Euro. Although we provide some initial interesting results, further progress in this area will require deeper information on firms’ characteristics to identify different welfare gains from trade, mainly in specific sectors of the economy.
REFERENCES


Department of Economics, Finance and Legal Studies, University of Alabama.


APPENDIX A – FIGURES

Notes: This figure displays the evolution of annual Portuguese exports, and their components, to Euro Zone (EZ – solid lines) and non-Euro Zone (NEZ – dashed lines) destinations over the period 1995-2002. All series are normalized to 100 in 1999.

Figure 1 – Evolution of Portuguese Exports, 1995-2002
Notes: This figure shows the evolution of monthly series of the Portuguese trade margins, as defined in Section 4.3.1, over the period 1995-2002.

Figure 2 – Evolution of the Portuguese Trade Margins, 1995-2002
Notes: This figure displays, for the period 1995-2002, the monthly series of Portuguese trade margins seasonally adjusted (s.a.) (solid lines) and approximated by a nonlinear Fourier trend (dashed lines).

Figure 3 – Fourier Trend Approximation, 1995-2002
APPENDIX B – TABLES

Table I

Sample of Countries used in the Empirical Investigation

<table>
<thead>
<tr>
<th>Euro Zone Countries (9)</th>
<th>non-Euro Zone Countries (18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Australia</td>
</tr>
<tr>
<td>“Belux”</td>
<td>Canada</td>
</tr>
<tr>
<td>Finland</td>
<td>Czech Republic</td>
</tr>
<tr>
<td>France</td>
<td>Denmark</td>
</tr>
<tr>
<td>Germany</td>
<td>Hungary</td>
</tr>
<tr>
<td>Ireland</td>
<td>Iceland</td>
</tr>
<tr>
<td>Italy</td>
<td>Japan</td>
</tr>
<tr>
<td>Netherlands</td>
<td>South Korea</td>
</tr>
<tr>
<td>Spain</td>
<td>Mexico</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>New Zealand</td>
</tr>
<tr>
<td>Canada</td>
<td>Norway</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>Poland</td>
</tr>
<tr>
<td>Denmark</td>
<td>Slovakia</td>
</tr>
<tr>
<td>Hungary</td>
<td>Sweden</td>
</tr>
<tr>
<td>Iceland</td>
<td>Switzerland</td>
</tr>
<tr>
<td>Japan</td>
<td>Turkey</td>
</tr>
<tr>
<td>South Korea</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Mexico</td>
<td>United States</td>
</tr>
</tbody>
</table>

Notes: This table displays the set of countries considered in the empirical analysis. Exports to these countries represent 91% of total Portuguese exports over the period 1995-2002. “Belux” represents a single destination composed by Belgium and Luxembourg altogether.
### Table II

**Summary Statistics, Portugal, 1999**

<table>
<thead>
<tr>
<th></th>
<th>Euro Zone</th>
<th>Non-Euro Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of exporting firms</td>
<td>17,791</td>
<td>14,156</td>
</tr>
<tr>
<td>Number of products exported</td>
<td>16,936</td>
<td>13,165</td>
</tr>
<tr>
<td>Number of firm-product pairs</td>
<td>61,317</td>
<td>38,862</td>
</tr>
<tr>
<td>Avg. Exports per firm-product pair</td>
<td>237,951</td>
<td>137,301</td>
</tr>
</tbody>
</table>

Notes: This table shows some descriptive statistics of Portuguese exports to Euro Zone and non-Euro Zone destinations, in 1999. A product is defined as a distinct eight-digit Combined Nomenclature code. Average exports are expressed in 1999 thousands Euro.

### Table III

**Growth Rates of Portuguese Exports (%)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Euro Zone</th>
<th></th>
<th>Non-Euro Zone</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Exports</td>
<td>31.6</td>
<td>18.5</td>
<td>26.6</td>
<td>13.7</td>
</tr>
<tr>
<td>Firms</td>
<td>7.5</td>
<td>1.5</td>
<td>8.7</td>
<td>6.5</td>
</tr>
<tr>
<td>Products</td>
<td>0.3</td>
<td>4.8</td>
<td>8.2</td>
<td>12.4</td>
</tr>
<tr>
<td>Shipments</td>
<td>15.9</td>
<td>5.4</td>
<td>14.8</td>
<td>6.9</td>
</tr>
</tbody>
</table>

Notes: This table reports growth rates of Portuguese exports and some of their components (firms, products and shipments) for the Euro Zone and non-Euro Zone, over the periods 1995-1998 and 1999-2002.
### Table IV

OLS Regression Decomposition of Portuguese Exports across Trading Partners, 1995-2002

<table>
<thead>
<tr>
<th>Year</th>
<th>Margin</th>
<th>OECD</th>
<th>Euro Zone</th>
<th>non-Euro Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Firms</td>
<td>0.590*** (0.039)</td>
<td>0.425*** (0.040)</td>
<td>0.639*** (0.057)</td>
</tr>
<tr>
<td></td>
<td>Products</td>
<td>0.501*** (0.027)</td>
<td>0.439*** (0.058)</td>
<td>0.504*** (0.035)</td>
</tr>
<tr>
<td></td>
<td>Density</td>
<td>-0.388*** (0.031)</td>
<td>-0.308*** (0.054)</td>
<td>-0.404*** (0.042)</td>
</tr>
<tr>
<td></td>
<td>Avg. Exports</td>
<td>0.297*** (0.035)</td>
<td>0.444*** (0.046)</td>
<td>0.261*** (0.056)</td>
</tr>
<tr>
<td>1995</td>
<td>Firms</td>
<td>0.583*** (0.041)</td>
<td>0.450*** (0.043)</td>
<td>0.632*** (0.064)</td>
</tr>
<tr>
<td></td>
<td>Products</td>
<td>0.505*** (0.031)</td>
<td>0.457*** (0.060)</td>
<td>0.508*** (0.043)</td>
</tr>
<tr>
<td></td>
<td>Density</td>
<td>-0.384*** (0.030)</td>
<td>-0.317*** (0.053)</td>
<td>-0.399*** (0.041)</td>
</tr>
<tr>
<td></td>
<td>Avg. Exports</td>
<td>0.296*** (0.041)</td>
<td>0.409*** (0.055)</td>
<td>0.258*** (0.069)</td>
</tr>
<tr>
<td>1996</td>
<td>Firms</td>
<td>0.565*** (0.035)</td>
<td>0.448*** (0.046)</td>
<td>0.609*** (0.059)</td>
</tr>
<tr>
<td></td>
<td>Products</td>
<td>0.484*** (0.027)</td>
<td>0.458*** (0.058)</td>
<td>0.484*** (0.038)</td>
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<tr>
<td></td>
<td>Density</td>
<td>-0.375*** (0.028)</td>
<td>-0.311*** (0.054)</td>
<td>-0.385*** (0.039)</td>
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<tr>
<td></td>
<td>Avg. Exports</td>
<td>0.326*** (0.034)</td>
<td>0.405*** (0.058)</td>
<td>0.293*** (0.060)</td>
</tr>
<tr>
<td>1997</td>
<td>Firms</td>
<td>0.554*** (0.029)</td>
<td>0.439*** (0.042)</td>
<td>0.608*** (0.051)</td>
</tr>
<tr>
<td></td>
<td>Products</td>
<td>0.463*** (0.022)</td>
<td>0.430*** (0.056)</td>
<td>0.477*** (0.031)</td>
</tr>
<tr>
<td></td>
<td>Density</td>
<td>-0.363*** (0.024)</td>
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<tr>
<td></td>
<td>Avg. Exports</td>
<td>0.345*** (0.027)</td>
<td>0.422*** (0.064)</td>
<td>0.297*** (0.050)</td>
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<tr>
<td>1998</td>
<td>Firms</td>
<td>0.529*** (0.024)</td>
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<tr>
<td></td>
<td>Products</td>
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<tr>
<td></td>
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<td>Years</td>
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<td>Products</td>
<td>Density</td>
<td>Avg. Exports</td>
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<td>-----------</td>
<td>------------</td>
<td>--------------</td>
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<td>2000</td>
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<tr>
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<td>(0.042)</td>
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<td>-0.274***</td>
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<td>(0.025)</td>
<td>(0.039)</td>
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<tr>
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<td></td>
<td>(0.027)</td>
<td>(0.065)</td>
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<tr>
<td>2001</td>
<td>0.515***</td>
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<td>(0.022)</td>
<td>(0.026)</td>
<td>(0.037)</td>
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<td>0.384***</td>
<td>0.450***</td>
<td>0.326***</td>
<td></td>
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<td>(0.031)</td>
<td>(0.063)</td>
<td>(0.052)</td>
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</tr>
<tr>
<td>2002</td>
<td>0.506***</td>
<td>0.427***</td>
<td>0.561***</td>
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</tr>
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<td></td>
<td>(0.027)</td>
<td>(0.041)</td>
<td>(0.048)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.418***</td>
<td>0.413***</td>
<td>0.435***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
<td>(0.047)</td>
<td>(0.032)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.332***</td>
<td>-0.272***</td>
<td>-0.356***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
<td>(0.028)</td>
<td>(0.035)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.409***</td>
<td>0.432***</td>
<td>0.361***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
<td>(0.066)</td>
<td>(0.045)</td>
<td></td>
</tr>
</tbody>
</table>

Notes: This table displays, for each year from 1995 to 2002, the OLS decomposition (see Section 4.1) of variation in Portuguese exports across trading partners along four trade margins: the number of exporting firms, the number of products exported, the density of trade and the average firm-product exports. Each cell reports the estimate of the slope parameter, $\beta_i$, and the standard error (in parentheses) of a different regression according to equation (2) in Section 4.2 for three different sub-samples of countries: OECD (27 countries), Euro Zone (9 countries) and non-Euro Zone (18 countries).

Significance levels: *10%, **5%, ***1%. Robust standard errors in parentheses.
### Table V

#### Unit-Root Test on Trade Margins

<table>
<thead>
<tr>
<th></th>
<th>(a) Best Frequency Selected</th>
<th>(b) F-test for a Structural Break</th>
<th>(c) Unit-Root Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Margin</td>
<td>SSR ((k=1))</td>
<td>SSR ((k=2))</td>
</tr>
<tr>
<td>Firms</td>
<td>SSR((k=1))</td>
<td>244524.79</td>
<td>333021.97</td>
</tr>
<tr>
<td>Products</td>
<td>SSR((k=1))</td>
<td>259993.65</td>
<td>230476.45</td>
</tr>
<tr>
<td>Density</td>
<td>SSR((k=1))</td>
<td>1.13d-08</td>
<td>1.29d-08</td>
</tr>
<tr>
<td>Avg. Exports</td>
<td>SSR((k=1))</td>
<td>1.06d+09</td>
<td>1.13d+09</td>
</tr>
</tbody>
</table>

Notes: Panel (a) shows, for each series, the resulting “Sum of Squared Residuals” (SSR) from the estimation of equation (6) in Section 4.3.2, augmented with eleven monthly dummies and estimated for the single frequencies \(k = 1, 2, 3, 4, 5\). The last column reports the estimated frequency that results from the equation with the lowest SSR. Panel (b) displays the results of the \(F\)-test of equations (9) and (10), for a structural break in the margins’ series. The critical value is reported in Table 1c, column 3, of Enders & Lee (2009). Panel (c) reports the Dickey-Fuller (DF) unit root-tests on each trade margin. In the first row it is applied the nonlinear DF test proposed by Enders & Lee (2009) while in the other three it is performed the usual linear DF test. It is reported the lag length chosen for equation test (7) augmented with eleven monthly dummies (second column), the \(t\)-statistic of the test (third column) and the critical values for the test (fourth column).
### Table VI

**Euro Effects Constant over Time**

<table>
<thead>
<tr>
<th>Margin</th>
<th>Firms</th>
<th>Products</th>
<th>Density</th>
<th>Avg. Exports</th>
</tr>
</thead>
<tbody>
<tr>
<td>( EZ_{it} )</td>
<td>(-0.009 )</td>
<td>(-0.079^{**} )</td>
<td>(0.174^{***} )</td>
<td>(0.224^{***} )</td>
</tr>
<tr>
<td>&amp; ((0.030)) &amp; ((0.038)) &amp; ((0.051)) &amp; ((0.068))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \ln(rgdp_{it}) )</td>
<td>(0.492)</td>
<td>(0.496^{*})</td>
<td>(-0.652)</td>
<td>(-0.112)</td>
</tr>
<tr>
<td>&amp; ((0.300)) &amp; ((0.297)) &amp; ((0.559)) &amp; ((0.482))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \ln(rer_{it}) )</td>
<td>(-0.432^{**})</td>
<td>(-0.319^{*})</td>
<td>(0.364^{***})</td>
<td>(-0.408^{**})</td>
</tr>
<tr>
<td>&amp; ((0.152)) &amp; ((0.180)) &amp; ((0.090)) &amp; ((0.188))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>(-2.242)</td>
<td>(-2.540)</td>
<td>(7.154)</td>
<td>(7.701)</td>
</tr>
</tbody>
</table>

Observations: 216

Fixed Effects: Destination, Year

Notes: This table reports estimations results from equation (11) for each trade margin. The Euro effects are assumed to be present from 1999 onwards and to be constant over time. Significance levels: *10%, **5%, ***1%. Standard errors in parentheses are clustered at the destination-level.
### Table VII

**Time Varying Euro Effects**

<table>
<thead>
<tr>
<th>Margin</th>
<th>$f_{it}$</th>
<th>$p_{it}$</th>
<th>$d_{it}$</th>
<th>$x_{it}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>EZ96$_{it}$</td>
<td>0.047***</td>
<td>0.039*</td>
<td>0.027</td>
<td>0.034</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.021)</td>
<td>(0.042)</td>
<td>(0.077)</td>
</tr>
<tr>
<td>EZ97$_{it}$</td>
<td>0.062**</td>
<td>0.036</td>
<td>0.071</td>
<td>0.118</td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
<td>(0.034)</td>
<td>(0.050)</td>
<td>(0.076)</td>
</tr>
<tr>
<td>EZ98$_{it}$</td>
<td>0.024</td>
<td>0.034</td>
<td>0.092</td>
<td>0.243***</td>
</tr>
<tr>
<td></td>
<td>(0.037)</td>
<td>(0.772)</td>
<td>(0.098)</td>
<td></td>
</tr>
<tr>
<td>EZ99$_{it}$</td>
<td>0.082***</td>
<td>0.006</td>
<td>0.147***</td>
<td>0.260**</td>
</tr>
<tr>
<td></td>
<td>(0.029)</td>
<td>(0.043)</td>
<td>(0.073)</td>
<td>(0.117)</td>
</tr>
<tr>
<td>EZ00$_{it}$</td>
<td>0.038</td>
<td>-0.040</td>
<td>0.219***</td>
<td>0.293**</td>
</tr>
<tr>
<td></td>
<td>(0.037)</td>
<td>(0.058)</td>
<td>(0.069)</td>
<td>(0.148)</td>
</tr>
<tr>
<td>EZ01$_{it}$</td>
<td>0.020</td>
<td>-0.071</td>
<td>0.260***</td>
<td>0.378***</td>
</tr>
<tr>
<td></td>
<td>(0.042)</td>
<td>(0.066)</td>
<td>(0.094)</td>
<td>(0.124)</td>
</tr>
<tr>
<td>EZ02$_{it}$</td>
<td>-0.017</td>
<td>-0.144**</td>
<td>0.265***</td>
<td>0.402***</td>
</tr>
<tr>
<td></td>
<td>(0.056)</td>
<td>(0.069)</td>
<td>(0.100)</td>
<td>(0.113)</td>
</tr>
<tr>
<td>$\ln(rgdp_{it})$</td>
<td>0.491</td>
<td>0.495*</td>
<td>-0.071</td>
<td>-0.019</td>
</tr>
<tr>
<td></td>
<td>(0.305)</td>
<td>(0.286)</td>
<td>(0.538)</td>
<td>(0.449)</td>
</tr>
<tr>
<td>$\ln(rer_{it})$</td>
<td>-0.472***</td>
<td>-0.358**</td>
<td>0.356***</td>
<td>-0.437**</td>
</tr>
<tr>
<td></td>
<td>(0.151)</td>
<td>(0.179)</td>
<td>(0.085)</td>
<td>(0.198)</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.246</td>
<td>-2.519</td>
<td>7.518</td>
<td>5.707</td>
</tr>
<tr>
<td></td>
<td>(6.375)</td>
<td>(5.990)</td>
<td>(11.235)</td>
<td>(9.387)</td>
</tr>
</tbody>
</table>

**Observations:** 216

**Fixed Effects:** Destination, Year

**Notes:** This table reports estimations results from equation (13) for each trade margin. The Euro effects are assumed to be present from 1996 onwards and are allowed to vary over years. Significance levels: *10%, **5%, ***1%. Standard errors in parentheses are clustered at the destination-level.
APPENDIX C – PROOFS

C.1. OLS Decomposition of Portuguese Exports

This section uses equations (1) and (2) in text to demonstrate that the OLS estimates of the four slope parameters in equation (2) (one for each trade margin in the dependent variable) sum to unity. This comes from the fact that applying the logs on Portuguese exports decomposition in equation (1) we get:

(1.c) \( \ln(x_{it}) = \ln(f_{it}) + \ln(p_{it}) + \ln(d_{it}) + \ln(x_{it}) \)

where \( \ln(x_{it}) = \ln(x_{it}) \) represents the natural logarithm of total exports to a given destination \( i \) and the four terms in the right hand side represents the natural logarithms of the four trade margins: firms (\( \ln(f_{it}) \)), products (\( \ln(p_{it}) \)), density (\( \ln(d_{it}) \)) and average firm-product exports (\( \ln(x_{it}) \)).

Rewriting equation (2) in text for each margin, we get:

(2.c) \( \ln(f_{it}) = c_{f} + \beta_{f} \ln(x_{it}) + u_{f,i}, \quad i = 1, 2, \ldots, n \),

(3.c) \( \ln(p_{it}) = c_{p} + \beta_{p} \ln(x_{it}) + u_{p,i}, \quad i = 1, 2, \ldots, n \),

(4.c) \( \ln(d_{it}) = c_{d} + \beta_{d} \ln(x_{it}) + u_{d,i}, \quad i = 1, 2, \ldots, n \),

(5.c) \( \ln(x_{it}) = c_{x} + \beta_{x} \ln(x_{it}) + u_{x,i}, \quad i = 1, 2, \ldots, n \),

and then we have

(6.c) \( \hat{\beta}_{f} + \hat{\beta}_{p} + \hat{\beta}_{d} + \hat{\beta}_{x} = 1 \),
i.e., using OLS, the sum of the four estimated slope parameters associated with each trade margin along (2.c) to (5.c) is equal to one.

The demonstration of (6.c) implies only basic algebra skills and it is somewhat straightforward. The Ordinary Least Squares estimate of each slope parameter from (2.c) to (5.c) is, respectively:

\[
\hat{\beta}_f = \frac{\sum_{i=1}^{n} (l_{xt_i} - \bar{l}_{xt})(l_{f_i} - \bar{l}_f)}{\sum_{i=1}^{n} (l_{xt_i} - \bar{l}_{xt})^2},
\]

(7.c) \[
\hat{\beta}_p = \frac{\sum_{i=1}^{n} (l_{xt_i} - \bar{l}_{xt})(l_{p_i} - \bar{l}_p)}{\sum_{i=1}^{n} (l_{xt_i} - \bar{l}_{xt})^2},
\]

(8.c) \[
\hat{\beta}_d = \frac{\sum_{i=1}^{n} (l_{xt_i} - \bar{l}_{xt})(l_{d_i} - \bar{l}_d)}{\sum_{i=1}^{n} (l_{xt_i} - \bar{l}_{xt})^2},
\]

(9.c) \[
\hat{\beta}_x = \frac{\sum_{i=1}^{n} (l_{xt_i} - \bar{l}_{xt})(l_{x_i} - \bar{l}_x)}{\sum_{i=1}^{n} (l_{xt_i} - \bar{l}_{xt})^2},
\]

(10.c)\[
where the “bar” above variables represents the respective sample average.

Therefore, using the properties of the summation operator, we get:

\[
\hat{\beta}_f + \hat{\beta}_p + \hat{\beta}_d + \hat{\beta}_x = \frac{\sum_{i=1}^{n} (l_{xt_i} - \bar{l}_{xt}) [ (l_{f_i} - \bar{l}_f) + (l_{p_i} - \bar{l}_p) + (l_{d_i} - \bar{l}_d) + (l_{x_i} - \bar{l}_x) ]}{\sum_{i=1}^{n} (l_{xt_i} - \bar{l}_{xt})^2} =
\]
Now, recovering equation (1.c) we can write: $lf_i + lp_i + ld_i + lx_i = lxt_i$ and $\overline{lf} + \overline{lp} + \overline{ld} + \overline{lx} = \overline{lxt}$. Thus, including this information in last equality above, yields:

$$\frac{\sum_{i=1}^{n} (lxt_i - \overline{lxt})(lxt_i - \overline{lxt})}{\sum_{i=1}^{n} (lxt_i - \overline{lxt})^2} = \frac{\sum_{i=1}^{n} (lxt_i - \overline{lxt})(lxt_i - \overline{lxt})}{\sum_{i=1}^{n} (lxt_i - \overline{lxt})^2} = \frac{\sum_{i=1}^{n} (lxt_i - \overline{lxt})^2}{\sum_{i=1}^{n} (lxt_i - \overline{lxt})^2} = 1.$$

### C.2. Estimating a Gravity Model

This section describes the methodology to estimate a gravity model using a panel data set. Therefore, the material presented next is a short review based on Silva & Tenreyro (2005), but adapted to the case of panel data models and when it is only available information on a single exporting country.

The usual approach considers a multiplicative form for the gravity models,

$$(11.c) \quad T_{it} = \exp(\beta'x_i) a_{it},$$

where $T_{it}$ is the exported value to destination country $i$ at time $t$, $x$ is the matrix of the explanatory variables (in which is also included destination and time dummies in order to control for the unobserved heterogeneity), $\beta$ is a vector of unknown parameters and $a_{it}$ is an error term which verifies $E[a_{it} | x_{it}] = 1$, such that $E[T_{it} | x_{it}] = \exp(\beta'x_{it})$. It is usual to estimate the following regression,
(12.c) \[ \ln(T_{it}) = \beta' x_{it} + e_{it}, \]

with \(e_{it} = \ln(a_{it})\) being now the error term. However, if \(a_{it}\) is heteroskedastic, with variance depending on the regressors, which it highly possible in practice, then, following the logic of Silva & Tenreyro (2005), we will have \(E[e_{it} | x_{it}] \neq 0\), since “the expected value of the logarithm of a random variable depends both on its mean and the higher-order moments of the distribution.” This implies that the OLS of the equation (12.c) is not an unbiased estimator of \(\beta\).

In their simulation study, the authors found a considerable bias in the usual OLS estimators whenever it was considered that kind of heteroskedasticity. In view of this, Silva & Tenreyro (2005) recommend to estimate the equation directly in levels by using the Poisson estimator. Therefore, for panel data models, equation (11.c) shall be estimated using the fixed effects Poisson estimator.