EURO, FIRM SIZE AND EXPORT BEHAVIOR

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Abstract

This paper provides a first attempt to assess the impact of the euro on the relationship between firm size and exports. We extend previous new-new trade theory models to derive some hypotheses that are tested using a representative sample of Spanish manufacturing firms. The results indicate that the introduction of the euro has remarkably weakened the role of firm size in the decision to export to the Eurozone. Moreover, the change in the proportion of exports to the Eurozone is negatively related to firm size. Our results suggest that the euro adoption has reduced the threshold size in order to export to Eurozone countries.

Key words: European Union; Euro; Firm size, New-new trade theory.

JEL Classification numbers: F14, L13.

1. Introduction

A significant number of studies have been devoted to examine the relationship between currency unions and trade since Rose's path-breaking study in 2000. Through the inclusion of a common currency dummy in a gravity model of bilateral trade, Rose (2000) found that countries in a currency union trade three times more than countries with different currencies. This surprising finding, commonly known as the "Rose effect", has given rise to much work questioning the extent of that effect.[1] Despite the qualms on Rose's seminal work and the significant empirical efforts to weaken the currency union effect, the evidence still points out the existence of an important positive impact of currency unions on trade. Rose and Stanley (2005), in their *meta-analysis* from thirty-four studies, conclude that currency unions increase bilateral trade by between 30 and 90 per cent.

A currency union that has received special attention from researchers and policy-makers is the Eurozone. Several papers have investigated the potential effect of the third phase of the Economic and Monetary Union (henceforth EMU) on trade using pre-1999 data (see, e. g., Dell'Ariccia, 1999, De Grauwe and Skudelny, 2000, and Rose and van Wincoop, 2001).[2] However, the availability of the required data to test for the "Rose effect" has propelled the number of papers studying the effect of EMU on trade.[3] The most well-known work is that written by Micco, Stein and Ordoñez (2003) who find that the effect of EMU on trade is positive and economically important ranging from 4 to 30 per cent depending on the sample and the estimation technique. Other studies, such as Barr, Breedon and Miles (2003), Flam and Nordström (2003 and 2006), Gil, Llorca and Martínez Serrano (2003), Piscitelli (2003), De Nardis and Vicarelli (2003), Faruqee (2004), and Baldwin and Di Nino (2006) obtain estimates of the effect of EMU on bilateral trade inside this range, and even larger (see, Bun and Klaassen, 2002,

Baldwin, Skudelny and Taglioni, 2005 and Gil, Llorca and Martínez Serrano, 2007). In sum, empirical evidence to date suggests that EMU has had a sizeable and statistically significant impact on trade flows between EMU members.[4] Moreover, there is no evidence of trade diversion; rather, it seems that euro also boosts trade with non-eurozone countries.[5]

Recently, researchers have moved one step forward by analysing the nature of the pro-trade effects of the euro rather than simply estimating its magnitude. Baldwin and Taglioni (2005), BT hereafter, and Baldwin, Skudelny and Taglioni (2005) have developed the first theoretical frameworks to explain why the creation of a currency union can have a positive impact on trade even once the elimination of exchange rate volatility has been taken into account.[6] These models focus on the decision of firms to enter the foreign market and belong to the so-called new-new trade theory (Melitz, 2003).[7] Baldwin and his co-authors show that, in a monopolistic competition set-up with sunk entry costs into export markets and differences in firm-level productivity, the effect of exchange rate uncertainty on trade is non linear. In particular, their model predicts a convex relationship between trade and exchange rate volatility.[8] A basic result of these models is that a reduction in exchange rate volatility raises both the sales per exporting firm (intensive margin) and the number of exporting firms (extensive margin), because the minimum size-class of firms that export falls as volatility decreases. Baldwin and Di Nino (2006) and Flam and Nordström (2006), using both six-digit export data but with different methods, provide the first attempts to determine whether the euro has boosted trade through the extensive margin as well as the intensive margin. However, these industry-level studies ignore the role of firms.

Recently, theoretical and empirical papers on international trade have increasingly focused on firms. Empirical research using micro-data sets suggests the

existence of a positive relationship between firm size and direct exports (Wagner, 2001). However, the aforementioned theoretical work points out that a currency union reduces the *threshold-size* to export due to the impact of the elimination of exchange rate volatility on variable production costs.

This paper digs deeper into this issue by examining the effect of an asymmetric exchange rate reduction on firms' exporting behaviour. To this end, we extend a previous model by BT (2005) to examine both the decision to export to different destinations as well as the proportion of sales to each market: partner and non-partner countries. Our model predicts that the reduction in exchange rate volatility boosts trade disproportionately with partner countries. First, it leads a number of small firms to begin exporting to that market. Secondly, it also brings about a deepening of existing export flows to that market, leading to an increase in the proportion of exports to the partners.

We use firm-level data to test the predictions of the theoretical model. In particular, we assess the role of firm size in the growth of trade prompted by the elimination of exchange rate volatility. The data set includes a representative sample of Spanish manufacturing firms during the period 1994-2002. To the best of our knowledge, this paper presents the first attempt to explore the impact of the euro on international trade at the firm level.

The remainder of the paper is organised as follows. Section 2 presents the theoretical model. Section 3 describes the data and the methodology. Section 4 discusses the empirical results. Finally, section 5 concludes.

2. Theoretical model

In this section, we develop a simple partial equilibrium model in order to examine the effect of a reduction in exchange rate volatility on firms' decision to export

and destination. The model rests upon BT (2005) that extends previous models on export decision by heterogeneous firms in presence of sunk costs (Roberts and Tybout, 1997; and Melitz, 2003) in order to assess the effect of exchange rate volatility on trade. In BT's model, the reduction of exchange rate volatility boosts trade by raising exports of existing exporters and by inducing more (relatively small) firms to begin exporting. Our model extends BT's model in order to investigate the effect of an asymmetric reduction in exchange rate volatility on different trade destinations. To this end, we consider two possible export destinations: Eurozone (partner countries) and the rest of the world (non-partner countries).

We start by inspecting the main determinants of the export decision in a simplifying version of Roberts and Tybout (1997). In that paper, a rational, profit-maximizing firm decides to (entry into) export when its expected profits from exporting, net of sunk costs, are positive. The main features of a simplified version of their model are sketched out below.

Define $\pi_{it}(z_t, y_{it})$ as the current variation in firm *i*'s gross operating profits from exporting (versus not exporting); where z_t is a vector of market characteristics (i.e. foreign demand conditions), and y_{it} is a vector of firm-level characteristics, such as capital stocks, productivity or R&D intensity. Let F be sunk entry costs that a firm faces when decides to start exporting. These costs completely depreciate immediately after exit from exporting. Besides, they are identical across firms and invariant over time. Moreover, a firm exporting in *t-1* that quits exporting in *t* obtains a payoff of $-X_{it}$. Consider the following indicator variable Y_{it} that takes value 1 if firm *i* exports in period *t*, and 0 otherwise. Therefore, firm *i*'s profits from exporting in period *t* are:

$$\Pi_{it} = Y_{it}\left[\pi_{it}(z_t, y_{it}) - F\left(1 - Y_{i,t-1}\right)\right] - X_{it}Y_{i,t-1}(1 - Y_{it}) \qquad (1)$$

Let $Y_{it}^{(+)} = \{Y_{it+j} \,|\, j \geq 0\}$ be the infinite sequence of export-participation values that maximizes the expected present value of firm *i*'s profits $V_{it}(\Omega_{it}) = \max_{Y_{it}^{+}} E_t(\sum_{j=t}^{\infty} \delta^{j-t} \Pi_{ij} \,|\Omega_{it})$, where δ is the discount factor and Ω_{it} the firm's specific information set.

The export decision of firm *i* is the value of Y_{it} that satisfies the Bellman's equation:

$$V_{it}(\Omega_{it}) = \max_{Y_{it}^{+}} \Pi_{it} + \delta E\{V_{i,t+1}(\Omega_{i,t+1}) \,|\, Y_{it}\} \tag{2}$$

Therefore, the entry (to export) condition for a non-exporting firm turns out to be:

$$\pi_{it}(z_t, y_{it}) + \delta\left[E_t(V_{i,t+1}(\Omega_{i,t+1})\right] \geq F \tag{3}$$

Thus, the decision to start exporting depends on current determinants, z_t and y_{it}, as well as the firm's expectations on their future values. In presence of sunk costs, entry barriers (sunk entry costs) are exit barriers when re-entry (into export) is a possibility, so that the current exporting status of a firm matters to explain its exporting status in the future. As a result, permanent shocks will have a stronger impact on firm's decisions than transitory ones (hysteresis hypothesis). Hence, the formation of a monetary union will presumably have a strong impact on the decision to export in the presence of sunk cost.

This paper presents a model that takes the basic approach above. Since the focus of this paper lies on the effect of exchange rate volatility on the firm's decision to export, risk aversion and firms' asymmetry are crucial and must be explicitly included in the export decision. In particular, following BT (2005), firms are assumed to discount revenue streams by a risk premium that is related to the stream's variance and a risk-aversion parameter. Hence, firms' goal is to maximize the following utility function, net of sunk entry costs F.

$$U - F = E\pi - R\left[\sigma^2\right] - F \tag{4}$$

where π stands for total operating profits, σ^2 is the variance of the exchange rate and R is the function that defines the risk premium.

Expression (4) points out that a firm's decision to begin exporting is the result of a trade-off between its uncertain operating profits from exporting and sunk entry costs. A firm will become an exporter as long as its utility from exporting surpasses its fixed entry costs into foreign markets. Thus, entry condition (4) is similar to that in Roberts and Tybout (1997) given that, *ceteris paribus*, the utility of profits is a monotonically increasing function of profits.

The model includes some key features in order to highlight the effect of reduced volatility on foreign-market destinations. First, it incorporates exchange rate volatility in a monopolistic competition model with increasing returns. Secondly, firms must incur entry-sunk costs (F) in order to enter each market i (domestic, D, Eurozone, E, and the rest of the world, W). Thirdly, firms are heterogeneous due to their different marginal costs of production, m. Hence, lower marginal cost firms are larger since they sell more units of output. Marginal cost of production is independent of sales destination. Finally, firms are risk-averse, and discount revenue streams by a risk premium R. Thus, firms first decide whether or not to enter each market. Then, they choose their sales in each market (if they entered); and, finally firms obtain their operating profits depending on the particular realization of the stochastic process of the exchange rate. The model is solved backwards, from the sales decision to the market-entry decision.

2.1 Optimal sales to each market

In this subsection, taking the number of active firms in each market as given, we work out the output that maximize risk-adjusted profits denominated in Home currency.

Following BT (2005), in order to make the model analytically tractable, we eliminate the interaction between varieties on the demand side of a standard monopolistic competition model. This assumption is innocuous for the logic of the model. In particular, assuming that the demand for each variety enters consumers' preferences symmetrically, quadratically and in an additively separate manner, each firm's demand in each market *i* takes the following form:

$$p_i = a - q_i \tag{5}$$

where a>0. Firms choose quantity in each market, which amounts to assume that markets are segmented. Thus, a firm faces a downward-sloping demand curve in each market. In this set-up, domestic firms have three possible destination markets: domestic, Eurozone and rest-of-the-world.

Non-exporter home-based firms

Home-based firms that only sell locally face no exchange rate uncertainty and choose their output level to maximize their operating profits.

$$\pi_D = (p_D - m) q_D \tag{6}$$

Hence, their optimal output level and profits are, respectively:

$$q_D^* = \frac{a-m}{2} \qquad \pi_D = \left(\frac{a-m}{2}\right)^2 - F \tag{7}$$

Home-based firms that export: to Eurozone (*E*); to the rest of the world (*W*)

Exporters face exchange rate risk given that the level of the exchange rate alters their marginal cost of selling to Home. In this paper, we distinguish between the exchange rate risk effects associated to currencies of Eurozone countries (*E*) and to those of the rest of the world (*W*).

The firms' operating profits are, respectively:

$$\pi_E = (p_E - s_E m\tau_E) q_E \qquad \pi_W = (p_W - s_W m\tau_W) q_W \tag{8}$$

where p_i is the price in the export-destination market i ($i=E,W$), q_i is per-firm export to market i, m is the firm's marginal production cost, s_i is the spot exchange rate (destination market currency price of Home currency), and τ_i is the ad-valorem tariff equivalent of all trade barriers ($\tau_i \geq 1$).

Assuming $R[\sigma^2] = \alpha Var(\pi)$, where α is a parameter that measures risk aversion, an exporting firm's problem is to choose its sales to each market, q_i:

$$\max_{q_i} E\pi_i - R\left[\sigma_i^2\right] = \left(p_i - s_i^e m\tau_i\right)q_i - \alpha\sigma_i^2\left(m\tau_i q_i\right)^2 \qquad i = \{E,W\} \tag{9}$$

where expected operating profits in destination i are $(p-s^e_i m\tau_i)q_i$, and s^e stands for expected spot exchange rate. The variance of profits is $\sigma^2_i (m\tau_i q_i)^2$, where σ^2_i is the variance of the spot rate s_i. Hence, a typical exporting firm's problem is to choose the sales level to each market q_i:

Solving the F.O.C., we obtain optimal exports level for each destination market:

$$q_E^* = \frac{\left(a - s_E^e m\tau_E\right)}{2\left(1+\alpha\tau_E^2 m^2\sigma_E^2\right)} \qquad q_W^* = \frac{\left(a - s_W^e m\tau_W\right)}{2\left(1+\alpha\tau_W^2 m^2\sigma_W^2\right)} \tag{10}$$

Substituting (10) back into (9), and normalising $s^e_E=1$ and setting $s^e_W=k\cdot s^e_E=k$, where k is a real number, the risk adjusted payoffs from exporting to market i by a firm with marginal cost m is:

$$U_E = \frac{\left(a - m\tau_E\right)^2}{4\left(1+\alpha\tau_E^2 m^2\sigma_E^2\right)} \qquad U_W = \frac{\left(a - km\tau_W\right)^2}{4\left(1+\alpha\tau_W^2 m^2\sigma_W^2\right)} \tag{11}$$

2.2 Market-Entry decision

We now turn into the decision to enter different markets. Given the optimal choice and its payoffs, firms decide whether to enter the domestic market, and whether to export to different destination markets. Firms face sunk entry costs into foreign markets that are related to researching domestic and foreign demand, to establishing

marketing channels, to adjusting product characteristics to meet both domestic and foreign tastes and quality and/or security standards in the destination market, and so on. In order to isolate the effect of exchange rate volatility on entry into export markets, we assume that these entry costs do not differ by export-destination market. Therefore, the firms' goal is to maximise their risk-adjusted profit (net of entry costs) denominated in Home currency:

$$s_i^e\left(U_i - F\right) - \sigma_i^2 \operatorname{var}\left(U_i - F\right) \qquad i = \{E, W\} \tag{12}$$

Thus, a firm will enter market *i* if its risk-adjusted net profits are positive. Since $var(U_i\text{-}F)$ is equal to zero, the entry condition turns out to be $s^e{}_i(U_i\text{-}F)$ that is positive if and only if $(U_i\text{-}F)$ is positive. From (12) we can work out the size thresholds to enter the two possible export markets:

$$m_E = \frac{a - 2\sqrt{F\left(1 + \alpha\sigma_E^2\left(a^2 - 4F\right)\right)}}{\tau_E\left(1 - \alpha\sigma_E^2 4F\right)} \qquad m_W = \frac{a - 2\sqrt{F\left(1 + \alpha\sigma_W^2\left(a^2 - 4F\right)\right)}}{\tau_W\left(1 - \alpha\sigma_W^2 4F\right)} \tag{13}$$

where, m_E and m_W are the minimum viable class-sizes for exporters to Eurozone countries and to the rest of the world, respectively.

2.3 Exchange rate volatility and trade. The effect of the Euro

The focus of this paper lies on investigating the effect of a permanent reduction (or even elimination) of exchange rate volatility on trade. To this end, we focus on the decision to export (whether or not to export as well as export levels) to different markets of a number of active firms.

The reduction in exchange rate volatility with the partner countries increases both the sales per exporting firm and the number of exporting firms to that market, leading to an increase in the proportion of exports to those countries. To examine this question, we carefully analyse equilibrium sales (expression (10)) and the size-threshold

conditions that delimit the number of firms in each market in equilibrium (expressions (13)) in turn. The two effects altogether lead to the convex relation between volatility and trade that, according BT, is beneath the "Rose effect".

a) Exports by existing exporters

From (10), it is clear that optimal export levels are decreasing in the volatility of bilateral spot exchange rates.[9]

$$\frac{\partial q_i}{\partial \sigma_i^2} = -\frac{1}{2}\frac{\left(a - s_i^e m\tau_i\right)\alpha\tau_i^2 m^2}{\left(1+\alpha\tau_i^2 m^2\sigma_i^2\right)} < 0 \qquad \frac{\partial q_i}{\partial \sigma_j^2} = 0 \quad i \neq j;(i,j = E,W) \tag{14}$$

In order to assess the differential effect in destination markets, we focus on the ratio between exports to destination markets and its variation with exchange rate volatility.

$$\frac{q_E^*}{q_W^*} = \frac{\left(a - s_E^e m\tau_E\right)\left(1+\alpha\tau_W^2 m^2\sigma_W^2\right)}{\left(a - s_W^e m\tau_W\right)\left(1+\alpha\tau_E^2 m^2\sigma_E^2\right)}$$

$$\frac{\partial\left(q_E^* / q_W^*\right)}{\partial \sigma_E^2} = -\frac{\left(a - s_E^e m\tau_E\right)\left(1+\alpha\tau_W^2 m^2\sigma_W^2\right)\left(\alpha\tau_E^2 m^2\right)}{\left(a - s_W^e m\tau_W\right)\left(1+\alpha\tau_E^2 m^2\sigma_E^2\right)^2} < 0 \tag{15}$$

Therefore, a reduction in bilateral exchange rate volatility in a specific area enhances exports to that area, raising the proportion of exports to it.

Furthermore, when $s^e_E=1$ and $\sigma^2_E=0$, expression (15) becomes:

$$\frac{q_E^*}{q_W^*} = \frac{\left(a - m\tau_E\right)\left(1+\alpha\tau_W^2 m^2\sigma_W^2\right)}{\left(a - s_W^e m\tau_W\right)}$$

Moreover, in the limit case of $s^e_E= s^e_W=1$ and $\sigma^2_E=\sigma^2_W = 0$

$$\frac{q_E^*}{q_W^*} = \frac{\left(a - m\tau_E\right)}{\left(a - m\tau_W\right)}$$

and only the different barriers to trade explain that $q_E \neq q_R$.

b) Number of exporters

We now turn into the effect of the reduction of exchange rate volatility on entry thresholds, and therefore on the number of exporters. From (13), the relationship between the size-thresholds is:

$$\frac{m_E}{m_W} = \frac{a - 2\sqrt{F\left(1+\alpha\sigma_E^2\left(a^2-4F\right)\right)}}{a - 2\sqrt{F\left(1+\alpha\sigma_W^2\left(a^2-4F\right)\right)}} \frac{\tau_W}{\tau_E} \frac{\left(1-\alpha\sigma_W^2 4F\right)}{\left(1-\alpha\sigma_E^2 4F\right)} \qquad [16]$$

Thus, the size threshold to enter Eurozone countries is lower than that to the rest of the world, providing that $\sigma^2_E=0$, and $\tau_W=\tau_E$. Thus, (16) becomes:

$$\frac{m_E}{m_W} = \frac{a - 2\sqrt{F}}{a - 2\sqrt{F\left(1+\alpha\sigma_W^2\left(a^2-4F\right)\right)}} \tau_W \left(1-\alpha\sigma_W^2 4F\right) \qquad [17]$$

Interestingly, the reduction of exchange rate volatility has a disproportionately higher effect on small (less efficient) firms. Since lower volatility increases the utility of profits and the impact is augmented by marginal costs, higher marginal cost firms (i.e. small firms) are more positively affected by the reduction of volatility. As a result, the elimination of exchange rate volatility in a market (Eurozone) will induce a number of small firms to become exporters to partner countries.

Summing up, the combination of heterogenous risk-averse firms with exchange rate volatility and market-entry sunk costs creates a size threshold to enter each market that depends on exchange rate volatility. Moreover, the elimination of exchange rate volatility (and, therefore, uncertainty) has a positive effect on the utility of profits, mainly for small firms, leading to a reduction in their marginal costs large enough, for some of them, as to overcome the fixed cost of exporting. This reduction in marginal costs also takes place for larger exporting firms, which optimally increase their exports to the market where exchange rate volatility has vanished. In addition, in the presence of sunk cost history matters, making permanent shocks have a stronger impact than transitory ones.

At an aggregate level (i.e. country trade data) the BT (2005) model predicts a convex relationship between exchange rate volatility and trade. This occurs because a reduction in exchange rate volatility boosts trade both by inducing existing exporters to export more and by inducing more firms to begin exporting. This is particularly true if the size distribution of firms skewed with a higher proportion of small firms. At a microeconomic level we should observe, *ceteris paribus*, a set of small firms to begin exporting to the market in which exchange rate uncertainty has been reduced together with a partial reallocation of total trade-relationships to that market

3. Data and empirical methodology

The data are drawn from the *Encuesta sobre Estrategias Empresariales* (ESEE, henceforth), an annual survey of Spanish manufacturing firms carried out since 1990. The ESEE is representative of the population of Spanish manufacturing firms with ten or more employees, classified by industry and size categories.[10] The ESEE provides information on a large set of firm-level variables, such as technological activities, employment, sales, industry and foreign trade.

The sample in this paper comprises those firms continuously operating over the period 1994-2002. Unfortunately, the ESEE does only provide information on market destinations every four years, starting in 1994. Moreover, this survey classifies firms exports into three possible foreign markets: EU, rest of OECD countries, and rest of the world. In this paper, we have merged the two last categories into one: rest of the world. The latter allows us isolating the impact of the Euro on export destinations. The analysis is carried out for a sample of 798 firms over the years 1994, 1998, and 2002.

At this point, it is important to notice two limitations of our data. First, the European Union was enlarged from 12 to 15 member States in 1995 with the inclusion

of Austria, Finland and Sweden. Secondly, the Eurozone members in 2002 were all EU countries, except for UK, Denmark and Sweden. However, this does not represent a major problem for the following reasons. On one hand, Spanish exports to the countries of the aforementioned enlargement merely account for about 3% of total exports to EU-15. On the other hand, Eurozone members account for 86% of total exports to EU-15.

Table 1 provides information on firm turnover in EU export market. We split firms into three types: *stoppers*, which are those firms exporting in year "t" but leaving the EU export market in year "t+4", *starters*, which are those firms that begin to export in year "t+4" and *both* which are those firm that export in year "t" and continue exporting in year "t+4". For each category we report the value of total exports (in euros), the number of firms and its average size. We also report the changes occurred between the periods: 1994-1998 and 1998-2002.

At first glance, comparing the two periods under study we find coincidences but also relevant differences. Firstly, the bulk of exports in both periods come from those firms with continuous presence in the EU export market (*both*), which are also the largest firms. Secondly, as it is observed, the number of *starters* and *stoppers* is relatively small. Nonetheless, the total number of exporting firms clearly increases between 1994 and 1998 (about 15%), but remains practically unaltered between 1998 and 2002, since the number of *starters* and *stoppers* is almost identical during the latter period. Thirdly, the average size of those firms beginning to export in 2002 to the EU is notably smaller than that of those firms that began to export in 1998 (discounting the fact that some of them were exporters to the countries of the fourth enlargement) and even smaller than the size of the *stoppers*. Finally, and most importantly, considering altogether the number of firms and average size (that is, the product of both variables that could be called "total size") for *starters* and *both,* we see that the *starters* amount to

around 2.75% of the "total size" of the continuing exporters to the EU, but their contribution to total exports increase is 9.68%.

In order to assess the effect of the euro on the role of size on the firms' decisions to export, we proceed in two stages. First, a probit model for the decision to export to different destinations (partner and non-partner countries) is carried out. Secondly, the effect of euro on different market destinations is estimated by two cross-section regressions (for the periods 1994-1998 and 1998-2002, respectively) in which the dependent variable is the change in the percentage of exports to the EU.

The decision of firms to export can be represented by a dummy variable y_{ijt} (where *i* denotes firm, *j* destination and *t* time), which takes the value of one when the firm export to destination *j* and zero otherwise. We estimate two equations, one for exports to EU countries and the other for exports to non-EU countries:

$$\Pr\left[y_{ijt}=1\right]=\Phi\left[\begin{array}{l}\beta_0+\beta_1 y_{ij(t-1)}+\beta_2 size_{it}+\beta_3 size^2{}_{it}+\beta_4 cycleEUrest_t \\ +\beta_5 productivity_{it}+\beta_6 R\,\&\,D_{it}+\alpha_k+\lambda_t+u_{ijt}\end{array}\right] \quad [18]$$

where Φ is the standard normal distribution, *size* is firm's employment, *cycleEUrest* is a firm-level variable that aims at capturing relative demand conditions by destinations (proxied by the weighted difference between the GDP growth rate in EU and the rest of the world, where the weight is the firm's relative export share to EU and to the rest of the world), *productivity* is the labour productivity (valued added divided by employment), *R&D* is Research and Development intensity (that is, the ratio R&D expenditure to sales), α_k are industry dummies (NACE 2-digit level) and λ_t is a time dummy.

In order to explore the determinants in the variation proportion of exports to the EU we estimate the following equation:

$$\Delta y_{ijt}^{w} = \beta_0 + \beta_1 size_{it} + \beta_2 size_{it}^2 + \beta_3 productivitygrowth_{it} + \beta_4 cycleEUrest_t + \alpha_k + \lambda_t + u_{ijt} \quad [19]$$

where Δy_{ijt}^{w} is the change in the proportion of exports to the EU relative to exports to the rest of the world and *productivitygrowth* measures the change in productivity between the years considered.

4. Empirical results

To investigate the effect of the euro on the relationship between firm size and export behaviour, we start by estimating a probit model for the decision to export to the European Union. Table 2 displays the estimation results both for the full sample of firms as well as for small firms (up to 200 employees).[11] In each case, two specifications are estimated: first, a pooled regression of the two periods under study (adding a time dummy); secondly, two separate regressions, one for each single year (1998 and 2002). In general, the estimated coefficients have the expected sign and are statistically significant at conventional levels. As expected, sunk costs are quite relevant in all six estimations. That is, past export experience to the European market implies a high probability of current presence in that market. In addition, in line with the literature on exports and productivity (see Wagner, 2007, for a revision), high productive firms are more likely to be an exporter than low productive ones. We also obtain, in all regressions, that exports to the European Union are positively affected by a relatively favourable economic conjuncture in this area.

The effect of the other explanatory variables is more disperse across the different estimations. First, R&D intensity, as a proxy for innovation, is only relevant for the full sample (but not in 2002). This result is consistent with the competitive advantage of Spanish manufacturing firms in low and medium technologically intensive sectors

(Myro and Gandoy, 2007). In these sectors the firms competitive advantage relies less heavily on both size (scale economies) and innovation. Secondly, although as a general rule size influences in a positive and significant manner the export decision by firms (at a decreasing rate), this is not the case for small firms in 2002, where the effect of size is non-significant at the 5 percent significance level. This result suggests a shrinkage in the "threshold size" in order to enter the Eurozone export markets.

The regressions for the decision to export to non-European Union Markets are reported in Table 3. Interestingly, the role of size on the decision to export differs by destination. The effect of size on the decision to export to non-EU markets is always positive and statistically significant at 1%, even for small firms. Besides, the point estimate coefficient is even larger in 2002.

In sum, as predicted by our theoretical model, an asymmetric elimination of exchange rate volatility leads to a reduction in the threshold size to enter the partners market, whereas it has no effect on the size threshold to enter non-partner markets.

Moreover, the theoretical model establishes that an exchange rate volatility reduction (or elimination) increases the share of exports to EU market. In order to empirically test for this theoretical proposition, we run a regression with the change in the percentage of exports to the EU in relation to the rest of the world as the dependent variable. The results of an OLS regression are reported in Table 4. The estimated coefficients for the size variable strongly confirm our priors. When considering the full sample (pooled regression), the dependent variable is negatively affected by size (at a decreasing rate) and the estimated coefficients for the corresponding variables are statistically significant at the 5 per cent level. This is the expected result after the introduction of the euro. When we split the sample into two periods the picture that emerges is in line with our theoretical predictions. During the period 1994-1998, firm

size has no effect on the change of the ratio exports to UE to exports elsewhere. In contrast, over the period 1998-2002, after the introduction of the euro, a reduction in firm size is associated with an increase of the share of exports towards the EU. This result suggests that the euro adoption has reduced the threshold size in order to export to the Eurozone markets.

5. Conclusions

This paper provides a first attempt to check the impact of the euro on the relationship between firm size and both the decision to export and export share to the Eurozone. To this end, we extend previous theoretical models in the context of the new-new trade theory to explain the effect on an asymmetric reduction (elimination) of exchange rate volatility. Trade to the partner market is boosted through an increase in exports by existing exporters and through a reduction in the size threshold to enter that market. The combined effect is an increase in the proportion of exports to that market.

Using a representative sample of Spanish manufacturing firms during the period 1994-2002 we find empirical evidence supporting the theoretical predictions. The introduction of the euro has remarkably weakened the role of firm size in the decision to export to the Eurozone for firms under 200 employees. Moreover, the change in the proportion of exports to the European Union is negatively related to firm size. Therefore, our results suggest that the threshold size to enter Eurozone markets has fallen down as a result of the adoption of the euro.

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Table 1a.- Exports to the European Union by firm type (1994-1998)

Firm type	1994			1998			Change in exports	
	Exports (mill. €)	No firms	Average size	Exports (mill. €)	No firms	Average size	Mill. €	% of total
Stoppers	1.4	23	80	0	0	79	-1.4	-0.31
Starters	-	-	154	55.6	86	179	55.6	12.26
Both	645	412	323	1,044.4	412	312	399.4	88.05
All	646.4	435	311	1,100	498	289	453.6	100

Table 1b.- Exports to the European Union by firm type (1998-2002)

Firm type	1998			2002			Change in exports	
	Exports (mill. €)	No firms	Average size	Exports (mill. €)	No firms	Average size	Mill. €	% of total
Stoppers	30	42	118	0	0	105	-30.0	-16.82
Starters	-	-	86	18.4	43	96	18.4	10.31
Both	1,070	456	305	1,260	456	328	190.0	106.50
All	1,100	498	289	1,278.4	499	308	178.4	100

Table 2.- The decision to export to the European Union

	Full sample of firms			Small firms (≤200 employees)		
	Full period	1998	2002	Full sample period	1998	2002
Size	0.0020	0.0022	0.0020	0.0192	0.0250	0.0142
	(5.32)	(3.94)	(3.88)	(3.57)	(3.33)	(1.81)
$Size^2$	$-2.68x10^{-7}$	$-3.09x10^{-7}$	$-3.81x10^{-7}$	$-7.87x10^{-5}$	-0.0001	$-3.86x10^{-5}$
	(-4.75)	(-3.74)	(-3.55)	(-2.64)	(-2.94)	(-0.86)
Exported four years ago to the EU	2.3194	2.4586	2.2739	2.2011	2.3133	2.1846
	(18.08)	(11.48)	(13.25)	(15.29)	(9.84)	(11.84)
Productivity	$1.59x10^{-5}$	$2.09x10^{-5}$	$1.05x10^{-5}$	$1.94x10^{-5}$	$2.14x10^{-5}$	$1.73x10^{-5}$
	(4.69)	(3.74)	(2.64)	(4.36)	(3.44)	(3.19)
Cycle EU-rest	0.0070	0.0067	0.0082	0.0073	0.0067	0.0090
	(10.29)	(6.98)	(7.71)	(8.98)	(6.30)	(6.80)
R&D intensity	5.5865	7.8752	1.1541	3.3437	5.8734	-0.1836
	(2.24)	(2.37)	(0.32)	(1.03)	(1.40)	(-0.04)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Time dummy	Yes	No	No	Yes	No	No
Pseudo R^2	0.63	0.63	0.65	0.60	0.58	0.64
No Observations	1,596	798	798	1,101	549	552

Note: t-statistics in parentheses are robust to heteroscedasticity and autocorrelation.

Table 3.- The decision to export to non European Union countries

	Full sample of firms			Small firms (≤200 employees)		
	Full period	1998	2002	Full sample period	1998	2002
Size	0.0017	0.0017	0.0018	0.0220	0.0219	0.0242
	(5.61)	(3.65)	(4.79)	(4.83)	(3.33)	(3.77)
$Size^2$	$-2.47x10^{-7}$	$-2.61x10^{-7}$	$-3.50x10^{-7}$	$-8.41x10^{-5}$	$-8.81x10^{-5}$	$-9.14x10^{-5}$
	(-6.00)	(-4.25)	(-4.43)	(-3.23)	(-2.28)	(-2.54)
Exported four years ago to the Non-EU	2.0358	2.1260	2.0286	2.1601	2.3735	2.1349
	(22.21)	(15.23)	(16.17)	(17.39)	(11.38)	(13.12)
Productivity	$5.17x10^{-6}$	$2.78x10^{-6}$	$6.48x10^{-6}$	$8.28x10^{-6}$	$6.22x10^{-6}$	$9.40x10^{-6}$
	(2.42)	(0.80)	(2.39)	(3.33)	(3.44)	(3.09)
Cycle EU-rest	-0.0047	-0.0051	-0.0041	-0.0060	-0.0068	-0.0051
	(-9.92)	(-8.36)	(-5.40)	(-8.89)	(-7.28)	(-4.88)
R&D intensity	5.7095	8.6519	3.4703	2.6149	10.9096	-6.8185
	(2.48)	(2.48)	(1.08)	(0.76)	(2.55)	(-1.48)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Time dummy	Yes	No	No	Yes	No	No
Pseudo R^2	0.51	0.52	0.50	0.54	0.58	0.52
No Observations	1,596	798	798	1,101	549	552

Note: t-statistics in parentheses are robust to heteroscedasticity and autocorrelation.

Table 4.- Change in percentage of exports to European Union and size

	Pooled regression	1994-1998	1998-2002
Size	-0.0060	-0.0029	-0.0108
	(-1.95)	(-0.62)	(-2.35)
$Size^2$	$1.36x10^{-6}$	$7.74x10^{-7}$	$3.00x10^{-6}$
	(2.35)	(1.17)	(1.94)
Productivity growth	4.5515	3.9859	4.7835
	(1.62)	(0.86)	(1.36)
Cycle EU-rest	0.1396	0.1376	0.1425
	(15.35)	(11.28)	(10.57)
Industry dummies	Yes	Yes	Yes
Time dummy	Yes	No	No
Adj. R^2	0.18	0.20	0.16
No Obs.	1,596	798	798

Note: t-statistics in parentheses are robust to heteroscedasticity and autocorrelation.

Footnotes

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[1] Critics of Rose's work have focused on several aspects. Persson (2001) emphasizes the problems of nonlinearity and self-selection. Tenreyro (2001) also poses the problem of endogenous selection. Pakko and Wall (2001) and Glick and Rose (2002) outline the need to take into account the time dimension. Thom and Walls (2002) criticize the fact that most currency unions in Rose's works involved very small or very poor nations. Rose and van Wincoop (2001) account for "multilateral (price) resistance terms". Nitsch (2002) and Levy-Yeyati (2003) focus on the aggregation bias arguing that the combination of distinct currency unions may hide heterogeneous results.

[2] Eleven member states of the European Union (Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain) formed a monetary union in 1999 (Greece joined in 2001). In 2002, it became a currency union. In 2008, the eurozone includes 15 EU member States.

[3] For a review of the literature about the euro's effect on trade, see Baldwin (2006) and Gil, Llorca and Martínez Serrano (2007).

[4] Nevertheless, it is worth noting that Vinhas de Souza (2002) finds inconclusive results and Berger and Nitsch (2005) and Gomes et al. (2006) suggest that the effect is statistically non-significant.

[5] See, for example, Micco, Stein and Ordoñez (2003) Flam and Nordström (2003), Baldwin and Di Nino (2006), and Gil, Llorca and Martínez Serrano (2007).

[6] Before the papers by Baldwin and his co-authors, there were only informal ideas on how a currency union can boost bilateral trade. Empirical studies of the euro's trade impact usually highlight three key mechanisms through which trade can increase: (1) by reducing exchange rate uncertainty, (2) by lowering transaction costs, and (3) by enhancing competition through greater price transparency.

[7] In addition to the standard assumptions of the new trade theory (Krugman, 1979 and 1980, and Helpman, 1981), the two key innovations in the new-new trade theory are (1) fixed cost of entering a new market and (2) differences in firm-level efficiency and, therefore, firm-level marginal production costs. Sunk costs are an important feature in exporting in the empirical work by Roberts and Tybout (1997), Bernard and Wagner (2001), Bernard and Jensen (2004) and others.

[8] Two sources of convexity emerge from the model. First, if volatility has a greater effect on small firms than on large, the marginal trade effect of a reduction in volatility is of a greater magnitude when, at the outset, more small firms are included in the set of exporting firms. Second, if the empirical distribution of firms is biased towards small firms (as occurs in the European Union) a reduction on the threshold size necessary to be an exporter will imply a larger number of new exporters.

[9] Notice that q^*_i for active firms in market *i* is strictly positive, which implies $a > s^e_i m \tau_i$.

[10] The sampling procedure of the ESEE is the following. Firms with less than 10 employees are excluded from the survey. Firms with 10 to 200 employees were randomly sampled by industry and size strata (according to 21 different productive activities and 4 size intervals), holding around a 4% of the population in 1990. All firms with more than 200 employees were requested to participate, obtaining a participation rate around 60% in 1990. Important efforts have been made to minimise attrition and annually incorporate new firms with the same sampling criteria as in the base year so

that the sample of firms is representative of the Spanish manufacturing sector over time (see http://www.funep.es for further details).

[11] The threshold size is 200 employees due to the sampling procedure of the ESEE. See section 3 for further details.