EURO, FIRM SIZE AND EXPORT BEHAVIOR

Silviano Esteve-Pérez*
Salvador Gil-Pareja
Rafael Llorca-Vivero
José Antonio Martínez-Serrano
University of Valencia

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Abstract

The goal of this paper is to assess the impact of the euro on the relationship between firm size and exports. We follow 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.

* Departamento de Estructura Económica, Facultad de Economía, Avda. de los Naranjos s/n, 46022 Valencia (Spain). Email: sesteve@uv.es Salvador.Gil-Pareja@uv.es; Rafael.Llorca@uv.es; Jams@uv.es. Tel.: 0034963828349. Fax: 0034963828354. This study is part of a research project financed by Ministerio de Ciencia y Tecnología (projects SEJ2006-07238/ECO and SEJ2008-04059), partially funded by the European Regional Development Fund (ERDF). The authors are grateful for the comments provided by two anonymous referees. The usual disclaimer applies.
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 variable in a gravity model of bilateral trade, Rose (2000) finds that trade between members of a currency union is about three times that between non-members. This striking finding, commonly known as the “Rose effect”, has prompted a large number of studies that have challenged the extent of the impact of currency unions on trade.\(^1\) Despite the qualms on Rose’s seminal work and the significant empirical efforts to weaken the currency union effect, the evidence so far still points out to the existence of an important positive impact of currency unions on trade. Rose and Stanley (2005), in their meta-analysis of thirty-four studies, conclude that currency unions boost bilateral trade. The magnitude of this effect ranges between 30 and 90 percent.

Researchers and policy-makers have intensively investigated the European Monetary Union. Some studies have examined the potential effect of the third phase of the Economic and Monetary Union (henceforth EMU) process on trade using data prior to 1999 (see, e. g., Dell’Ariccia, 1999, De Grauwe and Skudelný, 2000, and Rose and van Wincoop, 2001).\(^2\) Recently, the availability of more appropriate data to test for the “Rose effect” has propelled a number of papers devoted to examine the effect of EMU on trade.\(^3\) The most well-known is the work by Micco et al. (2003) who find that the effect of EMU on trade is positive and economically important. Its magnitude varies between 4 and 30 per cent depending on the sample and the estimation technique used. The effect of EMU on bilateral trade found by other studies either falls within this range (Barr et al., 2003; Flam and Nordström, 2003 and 2006; Gil et al., 2003; Piscitelli, 2003; De Nardis and Vicarelli, 2003; Faruqee (2004), and Baldwin and Di Nino, 2006).
or even larger (see, Bun and Klaassen, 2002; Baldwin et al., 2005 and Gil et al., 2008).
In sum, most of the empirical evidence to date suggests that EMU has had a modest but
positive impact on trade flows between EMU members. Furthermore, the analysis for
individual EMU members reveals the existence of a good deal of variation in the effect
of the euro across member countries. This impact is found to be particularly high for
Spain.

Recently, research has moved one step forward to analyse at a microeconomic
level the nature of these pro-trade effects of the euro rather than merely estimating their
magnitude. Baldwin and Taglioni (2004), BT hereafter, and Baldwin et al. (2005)
develop the first theoretical framework that explains why the creation of a currency
union can have a positive impact on trade. This work focuses on firms’ decisions to
enter foreign markets and falls within the so-called new-new trade theory (Melitz,
2003). Baldwin and his co-authors show that, in a monopolistic competition set-up
with sunk costs to enter 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. A basic
result of this model 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.

On empirical grounds, few studies have investigated the effect of the euro on the
extensive and intensive margins of trade. At an industry-level, Baldwin and Di Nino
(2006) and Flam and Nordström (2006), using a gravity approach on six-digit export
data provide the initial attempts to assess whether the euro has boosted trade through the
extensive margin as well as the intensive margin. These studies confirm that after the
euro adoption, the number of goods exported increased, which is evidence of the effect of the common currency on the extensive margin. However, these industry-level studies cannot provide evidence about the effect of the euro on firm behaviour.

To our knowledge, Berthou and Fontagné (2008) is the first paper that uses a firm-level data (on French exports over the period 1998-2003) to analyse the micro effects of the euro. These authors define the extensive margin as the number of varieties that are exported to each destination country, and the intensive margin as the average value of exports for each variety. They estimate two gravity equations with the intensive and extensive margins as the two dependent variables, and find that the euro has a positive effect on the extensive margin, but no effect on the intensive margin. Moreover, the descriptive analysis of the French data uncovers that the effect on the extensive margin is a consequence of the increase in the number of products exported by a firm rather than the effect of an increase in the number of exporting firms.\(^9\) Baldwin et al. (2008, Ch. 4) also provide descriptive statistics using firm-level Belgian data. Their results clearly show the existence of a pro-trade effect of the euro through the intensive and the extensive margins.\(^{10}\) De Nardis et al. (2008) using the gravity equation on data from Italian manufacturing firms over 1997-2001 also find a positive effect of the common currency on the extensive and intensive margins of trade. In particular, their results suggest a more important role of the extensive margin given the large number of non-exporting firms that enter the Eurozone market after 1999.

In line with this recent area of research this paper examines the effect of an asymmetric exchange rate reduction on firms’ exporting behaviour. To this end, we develop a simple extension of a previous model by BT (2004) in order 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 a reduction in
exchange rate volatility boosts trade with partner countries disproportionately. First, it leads a number of small firms to begin exporting to partner markets. Secondly, it also brings about a deepening of existing export flows to these markets, 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 preview our results, we find that the role of firm size in the decision to export to the Eurozone has remarkably weakened after the introduction of the euro. Moreover, the change in the proportion of exports to the Eurozone is negatively related to firm size. Thus, the results indicate that the euro has led to a reduction in the threshold size to export to Eurozone countries.

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 markets. The model closely follows BT (2004) that extends previous models on the 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 simplified 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 $\pi_i(t, y_u)$ 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 $y_u$ 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 $-X_u$.

Consider the following indicator variable $Y_i$ 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:

$$\Pi_i = Y_i \left[ \pi_i(z_t, y_u) - F(1 - Y_{i,t-1}) \right] - X_u Y_{i,t-1} (1 - Y_i)$$

(1)

Let $Y^{(+)}_u = \{Y_{u,j} \mid j \geq 0\}$ be the infinite sequence of export-participation values that maximizes the expected present value of firm $i$’s profits $V_u(\Omega_u) = \max_{Y_u} E(\sum_{j=0}^{\infty} \delta^{-j} \Pi_j(Y_u))$, where $\delta$ is the discount factor and $\Omega_u$ the firm’s specific information set.
The export decision of firm $i$ is the value of $Y_{it}$ that satisfies the Bellman’s equation:

$$V_{it}(\Omega_{it}) = \max_{\pi_{it}} \Pi_{it} + \delta E \left\{ V_{i,t+1}(\Omega_{i,t+1}) \mid Y_{it} \right\} \quad (2)$$

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

$$\pi_{it}(z_{it}, y_{it}) + \delta \mathbb{E} \left[ V_{i,t+1}(\Omega_{i,t+1}) \right] \geq F \quad (3)$$

Thus, the decision to start exporting depends on current determinants, $z_{it}$ 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 likely 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 a change in exchange rate volatility on a 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 (2004), firms are assumed to discount their revenue streams by a risk premium that is related to the stream’s variance and a risk-aversion parameter. Hence, a firm’s goal is to maximize the following utility function, net of sunk entry costs $F$.

$$U - F = E\pi - R\left[ \sigma^2 \right] - F \quad (4)$$

where $\pi$ stands for total operating profits, $\sigma^2$ 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 the sunk costs of
entry. 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 a reduction in 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 costs of production are 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 choose to enter previously); 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 we work out the output that maximize risk-adjusted profits denominated in Home currency taking the number of active firms in each market as given. Following BT (2004), 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:

\[ p_i = a - q_i \]  \hspace{1cm} (5)

where \(a > 0\). Firms choose quantity in each market, which amounts to assume that markets are segmented. Thus, they face 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 output level to maximize their operating profits.

\[ \pi_D = (p_D - m)q_D \]  \hspace{1cm} (6)

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

\[ q_D^* = \frac{a - m}{2} \quad \pi_D = \left(\frac{a - m}{2}\right)^2 - F_D \]  \hspace{1cm} (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 the domestic market. 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:

\[ \pi_E = \left( p_E - s_E m \tau_E \right) q_E \quad \pi_W = \left( p_W - s_W m \tau_W \right) q_W \]  \hspace{1cm} (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 \(\tau_i\) is the ad-valorem tariff equivalent of all trade barriers (\(\tau_i \geq 1\)).
As in BT (2004), we assume $R[\sigma^2] = \alpha Var(\pi)$, where $\alpha$ is a parameter that measures risk aversion. An exporting firm’s problem is to choose its sales to each market, $q_i$:

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

(9)

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

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

$$
q^*_E = \frac{a - s^{e}_Em\tau_E}{2(1 + \alpha \tau_E^2 m^2 \sigma_E^2)} \quad q^*_W = \frac{a - s^{e}_Wm\tau_W}{2(1 + \alpha \tau_W^2 m^2 \sigma_W^2)}
$$

(10)

Substituting (10) back into (9), 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 $i$ of a firm with marginal cost $m$ is:

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

(11)

2.2 Market-Entry decision

We now turn into the decision to enter different markets. Given the optimal sales by market and their 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, which 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 \((F_W = F_E = F > F_D)\). Therefore, the firms’ goal is to maximise their risk-adjusted profit (net of entry costs) denominated in Home currency:

\[
s_i^* (U_i - F) - \sigma_i^2 \text{var}(U_i - F) \quad i = \{E, W\}
\]  

(12)

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

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

(13)

where, \(m_E\) and \(m_W\) are the minimum size 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 goal 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 by a number of active firms.

The reduction in exchange rate volatility with partner countries increases both sales per exporting firm and the number of exporting firms to that market, leading to an increase in the proportion of exports to these countries. To examine this question, we carefully analyse equilibrium sales (equation 10) and the size-threshold conditions that delimit the number of firms in each market in equilibrium (equation 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 equation (10), it is clear that optimal export levels are decreasing in the volatility of bilateral spot exchange rates.\(^{11}\)

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

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

\[
q_E^* = \frac{(a - s^e E m \tau_E^o)(1 + \alpha \tau_E^2 m^2 \sigma_E^2)}{(a - s^e W m \tau_W^o)(1 + \alpha \tau_E^2 m^2 \sigma_E^2)}
\]

\[
\frac{\partial \left( \frac{q_E^*}{q_W^*} \right)}{\partial \sigma_E^2} = -\frac{(a - s^e E m \tau_E^o)(1 + \alpha \tau_E^2 m^2 \sigma_E^2) \left( \alpha \tau_E^2 m^2 \right)}{\left[ (a - s^e W m \tau_W^o)(1 + \alpha \tau_E^2 m^2 \sigma_E^2) \right]^2} < 0
\]

Therefore, a reduction in bilateral exchange rate volatility in a specific area (for instance, Eurozone countries) enhances exports to that area, raising the proportion of total sales to that market.

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

\[
q_E^* = \frac{(a - m \tau_E)(1 + \alpha \tau_E^2 m^2 \sigma_W^2)}{(a - s^e W m \tau_W^o)}
\]

Moreover, in the limit case of \(s^e_E = s^e_W = 1\) and \(\sigma_E^2 = \sigma_W^2 = 0\)

\[
\frac{q_E^*}{q_W^*} = \frac{(a - m \tau_E)}{(a - m \tau_W)}
\]

so that only the different barriers to trade explain that sales may differ by export markets (\(q_E \neq q_W\)).

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:

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

[16]

Thus, the size threshold to enter Eurozone countries is lower than that to the rest of the world, providing that \(\sigma_E^2 = 0\), and \(\tau_W \geq 1 = \tau_E\). Thus, (16) becomes:

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

[17]

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 start exporting 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 foreign market that depends on exchange rate volatility. Moreover, the complete elimination of exchange rate volatility (and, therefore, uncertainty) has a positive effect on the utility of profits, mainly for small firms. For some of them, this leads to a reduction in their marginal costs large enough 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 (2004) 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 making more firms begin exporting. This is particularly true if the size distribution of firms is 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 (partner countries) together with a partial reallocation of total trade-relationships to that market.

3. Data and empirical methodology

(i) Data

The data used in this paper are drawn from the *Encuesta sobre Estrategias Empresariales -Survey on Business Strategies* (ESEE, henceforth), which is 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. The ESEE provides information on a large set of firm-level variables, such as technological activities, employment, sales, industry and foreign trade.

In the empirical analysis we restrict attention to those firms that stayed in the survey over 1994-2002. Unfortunately, the ESEE does only provide information on destination-market of exports every four years, starting in 1994. Moreover, this survey classifies destination markets into three groups: EU, rest of OECD countries, and rest of the world. In this paper, we have merged the two latter categories into one comprising the rest of the world and labelled as Non-EU countries. By doing so, we focus on the impact of the Euro on export destinations. After cleansing the data we end up with a
sample of 2394 observations that correspond to 798 firms over the years 1994, 1998, and 2002.

It is important to bear in mind two caveats 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 in the empirical analysis for two reasons. On the 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 and 2 summarise the main characteristics of the dataset. In particular, they describe the pattern of export participation into EU and rest-of-world markets, respectively. We split firms into three groups: (i) *stoppers*, which are those firms exporting in year $t$ to a market that do not sell to that market in year $t+4$; (ii) *starters* are those firms that did not sell to that market in year $t$, but do sell to it in year $t+4$; (iii) and, *both* are those firm that sell to an export market in year $t$ and in year $t+4$. For each of the firm groups and export markets, we report the value of total exports (in millions of euros), the number of firms and their average size (number of employees). In the last column, the change in exports for each category and its contribution to the total change in exports is reported for 1994-1998 and 1998-2002.

At first glance, the comparison of the two periods under study in Table 1 (exports to EU) reveals some interesting results. First, the bulk of exports in both periods correspond to those firms with continuous presence in the EU export market (*both*). These firms are also the largest ones. Secondly, turnover in export markets is relatively important. The incidence of *stoppers* and, especially, *starters* is significant. In
particular, *starters* represent 17.3% of the total number of firms in the first period and 8.6% in the second. Moreover, the total number of exporting firms clearly increases between 1994 and 1998 (about 15%), but remains practically unaltered between 1998 and 2002, given that the number of *starters* and *stoppers* is barely the same in the latter period.\(^{14}\) Thirdly, the average size of those firms that begin to export to the EU in 2002 is remarkably smaller than that of those firms that began to export to partner countries in 1998, and even smaller than the size of *stoppers* (that is, exporters to UE in 1998 but not in 2002).

Table 2 displays firm export participation patterns into non-EU countries. Two remarkable differences arise when compared to the firm export behaviour to EU markets (Table 1). First, *starters* to non-EU are on average larger than their counterparts to EU markets, whereas the size advantage of exporters to non-EU markets is clearly smaller for continuing exporters. The smaller average size of export *starters* to the EU in the period 1994-98 with respect to those to non-EU is probably related to the lower trade barriers within the EU as a result of the Single Market. Secondly, and most importantly, the size of the export *starters* to non-EU markets slightly increases in the second period, which sharply differs from the reduction of the average size of firms that start to export to the EU in the second period. This evidence suggests that the euro has deepened the reduction in trade barriers within EU markets. Therefore, the preliminary evidence suggests that the euro adoption has led to a reduction in the threshold size in order to export to EU.

(ii) **Empirical methodology**

In order to assess the effect of the euro on the role of firm size in the decision to export, we proceed in two stages. First, we estimate a probit model for the decision to export to different destinations (partner and non-partner countries). Secondly, the effect
of euro on different market destinations is further examined through the estimations of a cross-section regression. In this case, the dependent variable is the change in the percentage of exports to the EU.

The firm decision to export can be modelled by a dummy variable $y_{ijt}$ (where $i$ denotes firm, $j$ destination and $t$ time), which takes the value of one when the firm exports to destination $j$ and zero otherwise. We estimate two separate models for each of the two destination markets considered ($j$=EU, non-EU):

$$
\Pr \left[ y_{ijt} = 1 \right] = \Phi \left[ \beta_0 + \beta_1 y_{ij(t-1)} + \beta_2 \text{size}_it + \beta_3 \text{size}_it \ast D_{2002} + \beta_4 \text{size}_it^2 + \beta_5 \text{size}_it^2 \ast D_{2002} + \beta_6 \text{cycleEUrest}_i + \beta_7 R & D_a + \alpha_k + u_{ijt} \right]
$$

where $\Phi$ is the standard normal distribution. The variable $\text{size}$ is measured with the firm’s number of employees. Besides, $\text{cycleEUrest}$ is a firm-level variable that aims at capturing relative demand conditions by destination markets. This variable is proxied by the weighted difference between the real GDP growth rate in EU and the rest of the world. The weights are the firm’s relative export share to EU and to the rest of the world (non-EU). Other control variables include Research and Development intensity ($R&D$), measured by the ratio of R&D expenditure to sales, and a set of industry dummies (NACE 2-digit level), $\alpha_k$. The variables $\text{size}$ and $\text{size squared}$ are interacted with a time dummy that takes the value of one for the year 2002 in order to capture whether the adoption of the euro has significantly altered the effect of firm size on the firms export behaviour. In this estimation, the effect of size on the decision to export in 2002 is obtained by summing up the coefficients of the variables size and size*D2002.

In order to explore the effect of size in the percentage change of exports to the EU, we estimate the following equation:
\[
\Delta y_{ijt} = \beta_0 + \beta_1 \text{size}_{it} + \beta_2 \text{size}_{it}^2 \cdot D_{2002} + \beta_3 \text{size}_{it} + \beta_4 \text{size}_{it}^2 \cdot D_{2002} + \beta_5 \text{cycleEUrest}_{it} + \alpha_t + u_{ijt}
\]  

[19]

where \( \Delta y_{ijt} \) is the change in the proportion of exports to the EU relative to exports to the rest of the world.

### 4. Empirical results

The empirical research using micro-data sets suggests the existence of a positive relationship between firm size and direct exports (Wagner, 2001). This paper is related to this strand of the literature. However, an important departure is that our primary goal is to investigate whether and how the euro has altered the relation between firm size and export behaviour. We start by estimating two separate probit models for the decisions to export to the EU and to non-EU markets.\(^{15}\) Table 3 displays the estimated marginal effects both for the full sample of firms as well as for small firms (up to 200 employees).\(^{16}\) In general, the estimates have the expected sign and are statistically significant at conventional significance levels.\(^{17}\) As expected, sunk costs are quite relevant. That is, past export experience into the EU and non-EU markets raises the probability of current participation in each of the markets. We also obtain that the decision to export to both areas is enhanced by a relatively favourable economic conjuncture. R&D intensity, as a proxy for innovation, increases export participation in the two markets for the full sample of firms. However, across small firms (those with less than 200 employees) it has no significant effect on the export decision to the two destination markets. This result is consistent with the general wisdom that Spanish small manufacturing firms endure competitive advantages in low and medium technologically intensive sectors (Myro and Gandoy, 2007).
With regard to the variable of interest, the estimated coefficients of size and size squared indicated that the decision to export is positively affected by size at a decreasing rate (in line with the existing literature on firm size and export behaviour – Wagner, 2001). More interestingly, when the variable size is interacted with the euro dummy (size*D2002) we find a non significant effect on the decision to export to non-EU markets but a negative and statistically significant effect on the decision to export to the EU markets. This result implies that the link between firm size and the decision to export becomes weaker after the introduction of the euro. Indeed, we reject the null hypothesis of equality of the effect of size on the decision to export to the EU market in 1998 and 2002. In particular, the impact of size on the decision to export to the EU in 2002 (obtained by summing up the coefficients of the variables size and size*D2002) is halved with respect to that in 1998, both for the full sample of firms as well as for small firms. In other words, the disadvantage of smaller firms in EU export markets has decreased substantially in 2002 with respect to 1998. This result, in addition to the preliminary evidence about the reduction in the average size of exporters to the EU in 2002 (which contrast with the increase in average size of exporter to non-EU market), could be interpreted as a reduction in the threshold size to export due to the adoption of the euro.

To further clarify this point, we provide an example using elasticities obtained from the estimations in Table 3 (full sample of firms). In particular, we work out elasticities evaluated at two points of the size distribution: a large firm with 300 employees and a small firm with 100 employees. The other variables are evaluated at their sample means. Before the introduction of the euro, other things equal, a 1% increase in size of the large firm is associated with a 0.3824% increase in its probability of exporting to EU (that is, an elasticity of 0.3824), whereas the same increase in size
for a small firm raises the probability of exporting to the EU in 0.1857%. The absolute difference between the two elasticities of 0.20 percentage points is halved after the introduction of the euro. In 2002, the effect of size on the probability of exporting to the EU significantly shrinks for all firms, as the elasticities fall to 0.1966 and 0.0987 for the large and the small firm of this example, respectively.

In the regression reported in Table 3 it is assumed that the explanatory variables and the error term are independent. This assumption may be inappropriate in our case. The error term may include an individual-specific time invariant effect $\mu_i$, that may be correlated with the explanatory variables, as well as a time-varying idiosyncratic random error $\epsilon_{it}$. Following Mundlak (1978) and Chamberlin (1980), we have used the within-individual mean of size to specify the possible correlation between the individual-specific component of the error term and the observed regressors. After adding the new variable to the set of regressors, the effect of the explanatory variables in the probit regression remains qualitatively and quantitatively similar to those of the standard probit regression.\(^\text{18}\)

Furthermore, the theoretical model also predicts an increase in the share of export to the partner countries (EU) as a result of an exchange rate volatility reduction (or elimination). In order to empirically test for this implication of the model, we run a regression (equation 19) using the change in the ratio between exports to the EU and exports to the rest of the world (non-EU) as the dependent variable. The OLS regression results are reported in Table 4, both for the full sample of firms as well as for the small firms (up to 200 employees). The estimated coefficients for the size variable and its interaction with the time dummy strongly confirm our priors in both samples. We find no effect of size on the change in the share of exports to EU in the first period of the analysis (1994-98). However, after the adoption of the euro (1998-2002) size has a
significant negative impact on the change in the ratio export to EU/export to non-EU. In fact, we reject the null hypothesis of equality of the effect of size on the change in the share of exports to UE markets in 1998 and 2002. This implies that trade barriers related to size suffer an asymmetric reduction in EU markets with respect to non-EU markets, but restricted to the period in which the single currency is introduced. Again, this result suggests that the euro adoption has reduced the threshold size in order to export to the Eurozone markets.

Before concluding it is worth noting that despite the fact that the impact of the euro is not easily measurable econometrically given the level of aggregation in export destinations (EU markets against non-EU markets), the preliminary results of section 3 as well as the econometric results point to a significant effect of the euro on the relationship between size and export decision.

5. Conclusions

This paper provides an attempt to investigate 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 have developed a simple extension to BT (2004) model in order to assess the effect of an asymmetric reduction of exchange rate volatility. 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.

Using a representative sample of Spanish manufacturing firms during the period 1994-2002 we find that the empirical evidence supports the theoretical predictions. 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 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.
References


Tenreyro, S. (2001): On the causes and consequences of currency unions, Harvard University,


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

<table>
<thead>
<tr>
<th>Firm type</th>
<th>1994</th>
<th>1998</th>
<th>Change in exports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exports (mill. €)</td>
<td>No. firms</td>
<td>Average size (No. employees)</td>
</tr>
<tr>
<td>Stoppers</td>
<td>1</td>
<td>23</td>
<td>80</td>
</tr>
<tr>
<td>Starters</td>
<td>-</td>
<td>-</td>
<td>154</td>
</tr>
<tr>
<td>Both</td>
<td>645</td>
<td>412</td>
<td>323</td>
</tr>
<tr>
<td>All</td>
<td>646</td>
<td>435</td>
<td>311</td>
</tr>
</tbody>
</table>

Note: Exports in millions of euros (at 2000 constant price)

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

<table>
<thead>
<tr>
<th>Firm type</th>
<th>1998</th>
<th>2002</th>
<th>Change in exports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exports (mill. €)</td>
<td>No. firms</td>
<td>Average size (No. employees)</td>
</tr>
<tr>
<td>Stoppers</td>
<td>30</td>
<td>42</td>
<td>118</td>
</tr>
<tr>
<td>Starters</td>
<td>-</td>
<td>-</td>
<td>86</td>
</tr>
<tr>
<td>Both</td>
<td>1,070</td>
<td>456</td>
<td>305</td>
</tr>
<tr>
<td>All</td>
<td>1,100</td>
<td>498</td>
<td>289</td>
</tr>
</tbody>
</table>

Note: Exports in millions of euros (at 2000 constant price)
Table 2a.- Exports to the Non European Union (non-EU) by firm type (1994-1998)

<table>
<thead>
<tr>
<th>Firm type</th>
<th>1994</th>
<th>1998</th>
<th>Change in exports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exports (mill. €)</td>
<td>No. firms</td>
<td>Average size (No. employees)</td>
</tr>
<tr>
<td>Stoppers</td>
<td>36</td>
<td>35</td>
<td>282</td>
</tr>
<tr>
<td>Starters</td>
<td>-</td>
<td>-</td>
<td>228</td>
</tr>
<tr>
<td>Both</td>
<td>360</td>
<td>301</td>
<td>351</td>
</tr>
<tr>
<td>All</td>
<td>396</td>
<td>336</td>
<td>344</td>
</tr>
</tbody>
</table>

Note: Exports in millions of euros (at 2000 constant price)

Table 2b.- Exports to the Non European Union (non-EU) by firm type (1998-2002)

<table>
<thead>
<tr>
<th>Firm type</th>
<th>1998</th>
<th>2002</th>
<th>Change in exports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exports (mill. €)</td>
<td>No. firms</td>
<td>Average size (No. employees)</td>
</tr>
<tr>
<td>Stoppers</td>
<td>16</td>
<td>45</td>
<td>185</td>
</tr>
<tr>
<td>Starters</td>
<td>-</td>
<td>-</td>
<td>238</td>
</tr>
<tr>
<td>Both</td>
<td>457</td>
<td>343</td>
<td>330</td>
</tr>
<tr>
<td>All</td>
<td>473</td>
<td>388</td>
<td>313</td>
</tr>
</tbody>
</table>

Note: Exports in millions of euros (at 2000 constant price)
Table 3.- Probit results (marginal effects) of the decision to export

<table>
<thead>
<tr>
<th></th>
<th>To European Union countries</th>
<th>To Non European Union countries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full sample of firms</td>
<td>Small firms (≤ 200 employees)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Full sample of firms</td>
</tr>
<tr>
<td>Exported four years ago to this market ($y_{t-1}$)</td>
<td>0.6582 (18.56)***</td>
<td>0.7244 (15.95)***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.7244 (15.95)***</td>
</tr>
<tr>
<td>CYCLE EU-rest ($y_{EU-rest}$)</td>
<td>0.0020 (10.20)***</td>
<td>0.0028 (9.02)***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-0.0020 (-8.38)***</td>
</tr>
<tr>
<td>R&amp;D intensity ($R&amp;D$)</td>
<td>1.4984 (2.11)**</td>
<td>1.5033 (1.20)</td>
</tr>
<tr>
<td></td>
<td>1.5033 (1.20)</td>
<td>2.1535 (2.36)**</td>
</tr>
<tr>
<td>Size</td>
<td>0.0010 (5.35)**</td>
<td>0.0111 (4.76)**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.0007 (4.27)**</td>
</tr>
<tr>
<td>Size<em>D2002 ($Size</em>D2002$)</td>
<td>-0.0005 (-2.60)**</td>
<td>-0.0064 (-3.27)**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.34x10^-5 (0.18)</td>
</tr>
<tr>
<td>Size^2 ($Size^2$)</td>
<td>-1.35x10^-7 (-5.54)**</td>
<td>-4.82x10^-7 (-3.71)**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-1.04x10^-7 (-4.72)**</td>
</tr>
<tr>
<td>Size^2<em>D2002 ($Size^2</em>D2002$)</td>
<td>4.01x10^-8 (1.15)</td>
<td>3.75x10^-7 (2.61)**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.75x10^-7 (2.61)**</td>
</tr>
<tr>
<td>Industry dummies, $\alpha_k$</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Pseudo R^2</td>
<td>0.62</td>
<td>0.58</td>
</tr>
<tr>
<td>No Observations</td>
<td>1,596</td>
<td>1,101</td>
</tr>
</tbody>
</table>

Note: t-statistics in parentheses correspond to standard errors robust to heteroskedasticity and autocorrelation. * significant at 10%; ** significant at 5%; *** significant at 1%.
Table 4.- Change in percentage of exports to European Union and size

<table>
<thead>
<tr>
<th></th>
<th>Full sample of firms</th>
<th>Small firms (≤ 200 employees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle EU-rest</td>
<td>0.1398 (15.32) ***</td>
<td>0.1579 (12.82) ***</td>
</tr>
<tr>
<td>Size</td>
<td>0.0015 (0.37)</td>
<td>0.0882 (0.91)</td>
</tr>
<tr>
<td>Size*D2002</td>
<td>-0.0173 (-3.37) ***</td>
<td>-0.2033 (-2.41) **</td>
</tr>
<tr>
<td>$Size^2$</td>
<td>1.66x10^-7 (0.29)</td>
<td>-0.0005 (0.84)</td>
</tr>
<tr>
<td>$Size^2*D2002$</td>
<td>3.98x10^-6 (2.31) **</td>
<td>0.0007 (1.26)</td>
</tr>
<tr>
<td>Industry dummies, $\alpha_t$</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Adj. R$^2$</td>
<td>0.18</td>
<td>0.20</td>
</tr>
<tr>
<td>No Obs.</td>
<td>1,596</td>
<td>1,101</td>
</tr>
</tbody>
</table>

Note: t-statistics in parentheses correspond to standard errors robust to heteroskedasticity and autocorrelation. * significant at 10%; ** significant at 5%; *** significant at 1%.
Footnotes

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 2009, the eurozone includes 16 EU member States.

3 For a review of the literature about the euro’s effect on trade, see Baldwin (2006) and Gil et al. (2008).

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, Gil et al. (2003), Baldwin and Di Nino (2006) and Baldwin et al. (2008).

6 Before the papers by Baldwin and his co-authors, there were only informal ideas on how a currency union could boost bilateral trade. Empirical studies on the effect of the euro on trade usually highlight three mechanisms: (1) through the reduction of exchange rate uncertainty, (2) by lowering transaction costs, and (3) by enhancing competition due to 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) a fixed cost of entering a new market and (2) differences in firm-level efficiency and, therefore, heterogeneity in firm-level marginal production costs. Sunk costs are an important determinant of 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 become an exporter will imply a larger number of new exporters.
This result is consistent with the general equilibrium model of multi-product firms developed by Bernard et al. (2006), who find that a reduction of variable trade costs induced by trade liberalization leads to firm selection into export markets but also increases the range of products that are exported by each firm.

Baldwin et al. (2008) also provide the results for two non-members of the Eurozone: Hungary and Sweden. In both cases the figures show little evidence of an unconditional newly-traded-goods effect when it comes to outsiders’ exports to the Eurozone.

Notice that $q_i^*$ for active firms in market $i$ is strictly positive, which implies $a > s^u_m \tau_i$.

Abel and Eberly (1996) showed, for the first time, that the effect of a complete elimination of uncertainty causes a discrete jump in behaviour in the context of optimal investment with costly reversibility.

The sampling scheme of the ESEE is the following. Manufacturing firms with less than 10 employees are excluded from the survey. Firms with 10 to 200 employees are randomly sampled by industry and size strata (according to 21 different productive activities and 4 size intervals), holding around a 4% of the population. All firms with more than 200 employees are requested to participate, obtaining a participation rate around 60%. Important efforts have been made to minimise attrition and annually incorporate new firms with the same sampling criteria as in the initial year so that the sample of firms is representative of the Spanish manufacturing sector over time.

As suggested by one of the referees there may also be an effect through the number of products exported. However, our data set does not allow controlling for this effect.

In this type of analysis endogeneity may be a problem. However, it does not represent a serious problem in our case given that the focus of analysis lies on investigating changes in export behaviour over 1998-2002. The implicit assumption is that other factor, which are not controlled for in the empirical analysis and that may prompt exports to UE countries, have not changed over this period.

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

The goodness of fit has been assessed by comparing predicted outcomes with actual outcomes. The percentage of correctly specified values is around 90 in all probit regression, with low rates of false positive and false negative classification errors.

The results of this robustness check are available from the authors upon request.