# EMU impact of on third countries' exports. A gravity approach

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***Abstract***. In this article we explore the impact of the euro adoption and the effect of the volatility of the real exchange rate on trade both on intra EMU trade and on EMU trade with third countries. To this end, we use a large database covering 93% of world trade that includes 80 countries during the period 1980-2009. We estimate a gravity equation using one of the most complete specifications in the literature to isolate the euro effect from other factors affecting trade, as regional trade agreements or exchange rate volatility. Our results show that the elimination of the volatility boosted export *per se* especially before 1999 and therefore, the possibility to peg to the euro could boost trade of third countries and between these third countries.

**Keywords** Gravity equation · International trade · Exchange rate

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## Introduction

More than ten years after the advent of the euro, the common currency has thrown in 2010 its worse crisis. The costs of loosing independence in monetary policy in case that members face asymmetric shocks has appeared clearly during the crisis faced by some countries like Greece. The crisis has raised all the issues raised ten years ago by Eurosceptics about the difficulties to share a common money without significant fiscal and political coordination. To convince Eurosceptics of the benefits of the common currency, the defenders of a unique European currency bet on large positive effect of the euro on trade and investment. Due to the policy relevance of the issue, in particular for the European countries that are still thinking about joining the European Monetary Union (EMU), it is important to have a robust evaluation of the benefits the euro had on trade and could still have since the debate is in the air. An interesting discussion on this topic is provided by De Grauwe (2011), revealing the most important successes and failures of EMU. Our objective in this article is to assess the effect of EMU on trade among the members of the eurozone and between the eurozone's members and other countries. To this end, we use the longer post euro period available at this date and try to control for all the possible effects the introduction of the euro had.

The main motives to expect large trade effects when adopting the euro were based on the beliefs that elimination of transaction costs and elimination of exchange rate volatility (ERV) should promote trade. Transaction costs could vary from 13.1-19€ billion according to the Emerson report (Emerson, 1992) and could represent a 0.3-0.4 per cent of GDP of exporters. Then, the impact was expected to be rather large. The expectations concerning the gains to obtain from the elimination of the ERV were less clear-cut. It might exist financial instruments to hedge against exchange rate risks. Though, these instruments are costly. In sum, the ex-ante effects of the elimination of

ERV and transaction costs were difficult to evaluate. Other potential gains were underlined but even more difficult to quantify. For instance, the euro may increase the degree of transparency of policies and make transactions among members similar to national ones. To change the money is a decision perceived as irrevocable, what in turn reduces the uncertainty and may increase all transactions including trade. Few years after the introduction of the euro, Baldwin et al. (2008) and Baldwin et al. (2005) have added another optimistic contribution to the debate: the effect of the elimination of the volatility when this volatility is small could have lead to a biggest increase in trade than a similar reduction when it is high. That is, they suggested a nonlinear relation between the volatility of exchange rate and trade. They argue that for lowest levels of the volatility, the elimination of this risk will lower export costs below a threshold that would allow more small firms to export. Since small firms represent a most important share of European firms, this would have a positive and non-proportional effect on trade[4]. Gil-Pareja et al. (2008) used this argument to explain why they found that monetary agreements among OECD countries have boosted trade, even when the elimination of volatility is controlled for.

From the entry of the euro, the euro first appreciated comparing to the dollar and then went depreciating until 2009. Now it fluctuates around its original level. The evolution of the real competitiveness followed a similar evolution (European Commission, 2010). Obviously, the overall competitiveness of the EMU affects the euroland trade and can bring changes in the price elasticities of import and export and

[4] 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. Berthou and Fontagné (2008) and Esteve-Pérez et al. (2011) offer an empirical verification of this proposal using respectively data for French and Spanish firms.

substitution. All in all, the world demand and supply of euro drive the level of the euro. But, the weight of the euro in the Central Bank assets of foreign countries and in debt has increased. This is a way to diversify the variability of their exchange rate and the value of their assets. This strategy in turn, affects the level of the euro and, afterwards, the level of trade of the eurozone. Then, we argue that the level of the exchange rate should be taken into account to quantify in a more realistic way the impact of the euro on trade.

We use an augmented gravity equation that explicitly takes into account the level and the volatility of the bilateral exchange rate, the presence of regional trade agreements (RTA) and the EMU. By this way, we are able to separate the specific trade effect of the euro from the trade impact of trade and monetary agreements. Our dataset covers bilateral exports for 80 countries (93 per cent of world trade) over the period 1967-2009.

To anticipate our most important findings, our study confirm that the common currency has had a positive impact on EMU exports, additionally to the fact that the elimination of the volatility of the exchange rate boosted export per se. This result reinforces the conclusions obtained by De Nardis (2004), which used a shorter period. The analysis for individual EMU members reveals the existence of a good deal of variation in the effect of the euro across member countries. Besides that, we provide evidence that the EMU has contributed to the expansion of some central and eastern European countries (CEE) exports. Finally, our study shows that the estimation technique leads to similar results for a basic model of trade flows. Additionally, it does not have a crucial impact on the conclusions concerning the effect of exchange-rate regimes – defined by the level and the volatility of the (real) exchange rate – on exports.

The rest of the article is organized as follows. In the next section we review the findings and the non solved challenges of the empirical literature that study the impact

of euro trade effects. Section II presents the empirical model and the data. In section III the estimation method is described. Finally, we comment the results in the fourth section.

## 1. Literature Review

Due to the success of the gravity equation to accurately reproducing real trade flows, this empirical model has been widely used by empirical researchers to study the sensibility of trade flows to a wide range of variables. Given the relevance of the issue, the effect of monetary arrangement and the common currency has also been studied in this framework. Contemporaneous of the beginning of the euro, the pioneer and famous article of Rose (2000) concluded that currency unions could triple trade among members. It became a challenge to confirm or detract these extraordinarily optimistic results and numerous studies have focused on the question of the impact of euro on trade after them. The study of Rose (2000) was based on a cross-section study involving heterogeneous countries and currency unions from 1970 with very different contexts than the eurozone; then economists thought that Rose's results were overestimating the effects of a currency union. But the idea that the euro could have a significant impact on trade gained weight in the debate and several studies after that have founded impacts quite smaller than Rose did, but still economically large.

Since the euro was adopted, and data for trade has become available, numerous studies have re-examined the question of the ex-post effects of the creation of the European Monetary Union (EMU) on trade. There are several challenges when dealing with this issue. One of them is to separate the impact of the elimination of ERV on flows from other effects of the euro like the elimination of transaction costs and other permanent changes associated with the new currency. This implies computing the volatility of the exchange rate for all country-pairs and a sufficiently long period and

large sample to capture differences in this variable among partners and time. Baldwin et al. (2005), Barr et al (2003), Brouwer et al. (2008) Dell'Ariccia (1999) and De Grauwe and Skuderlny (2000) all study the EMU effects controlling for ERV. However, an important specificity of the EMU is that all members are members of the Common market, and then the European Union (EU) effects should be distinguished from the EMU effect. Unfortunately, many studies do not take into account the additional effect of other RTAs. Another branch of gravity literature controls for the effect of RTAs and take into account the ERV but do not explicitly focus on the euro effect. Some examples are Rose (2000), Rose and Engel (2002), Clark et al. (2004), Lahrèche-Révil and Milgram (2006) and Tenreyro (2007). These authors measure the impact of ERV as the reduction in trade flows provoked by the increase in volatility by one standard deviation around its mean. The results range from 4-6 per cent in Tenreyro (2007) to 13 per cent in Rose (2000). Concerning the RTA coefficient, the results obtained differ slightly from one another. Tenreyro (2007) finds a negative influence of RTA on trade of 45 per cent, while the rest of authors obtain positive and significant results that varies from 32 to 145 per cent.

Recent empirical research includes the ERV as well as the euro impact and the effect of RTAs on trade. Gil-Pareja et al (2008) include a sample of 25 OECD countries for the period 1950-2004 to study the impact of monetary agreements. They conclude that monetary agreements and RTAs have a similar effect on bilateral trade among member countries once volatility is controlled for. De Nardis (2004) suggest that political and economic context of the euroland economies that pre-existed or accompanied the formation of EMU may have given rise to an independent increase in the share of intra-area trade that would bias estimates if trends are not taken into account. They explicitly address the issue of the persistence of trade using a dynamic panel framework. They conclude that euro had a short-run effect of 9-10 per cent on

intra-EMU trade and a 19 per cent in the long run. They qualify (surprisingly) this impact of small. This is a very interesting contribution but their estimations are based on a very short post euro period (1980-2000) that does not allow them to fully address this question[5]. Other examples are Baak (2004), Maliszewska (2004), and Bussière et al. (2008).

Micco et al. (2003) offer a very complete study to quantify the early effects of the euro using data for the 1982-2002 period. They take into account the level of the real exchange rate (RER) and their sample includes 22 industrialized countries. Their results suggest that the euro had a noticeable impact on trade (between 4 and 16 per cent), even at this early stage. Furthermore, EMU countries seem to have increased their trade with non-EMU countries. Though, they do not take into account the volatility of the exchange rate, and then it is impossible to know if this variation is only due to the elimination of the ERV or to the other effects. Flam and Nostrom (2006) also takes into account the RER but do not control for ERV or RTA. They find rather large effects of euro on trade –17 per cent for the 1999-2001 period and 28 per cent for 2002-06 –. Note that the timing they found is different from the ones of Micco et al (2003) and Belke and Spies (2008), whose results suggest that euro boosted trade more at the beginning than at the end of the period considered.

Baldwin et al. (2008) argue that using time-invariant dummies for countries will leave a time-varying component in the errors that may bias the studies of this kind. This would explain why authors find a larger euro effect when they use longer data sets. Obviously the longer the data set is the worse job a time-invariant dummy does in capturing the time-varying policy changes. To solve this problem, they interact EU dummies with some indicators of the financial and monetary integration to take into

[5] In this line, Bun and Klaassen (2007) and Berger and Nitsch (2008) find that the time trend reduces or makes the euro effect disappear. However, they do not take into account the ERV.

account the progressive achievements of these agreements. They still find a positive and highly significant, but small – about two per cent – effect of EMU on trade while they find EMU to be trade diverted.

Results in almost all cases show a positive effect of EMU on trade, though notably smaller than that predicted by Rose (2000), ranging from 2.6 per cent for the most pessimistic to 112 per cent for the most optimistic. Most of them conclude that EMU has had a positive impact on trade flows with non-EMU countries and that there are still potential trade increases associated with EMU enlargement and within EMU members. Furthermore, there is asserting consensus to consider that joining a monetary arrangement has an additional effect apart from the mere reduction of ERV.

Now, data for a sufficiently long post-euro period is available to, so it is possible to have a more precise ex-post evaluation of the euro effect. The methodological debate about the estimations of the gravity model has also evolved rapidly in recent years and this re-examination of the euro trade effect should take these considerations into account. Besides that, most of the recent literature makes the choice to focus on a reduced sample of developed countries which probably is more accurate when focusing on the effect of the common currency on European trade. Though, considering a larger sample is more precise to study the question of the impact of the euro on its trade with non-EMU countries and the opportunity that euro offers to other EU countries in terms of trade. Finally, most of the articles above mentioned do not include the exchange rate level or do not take into account the ERV in the specification. We claim that these variables have a significant effect on trade and should be included. Until the moment, any of the articles includes at the same time the level and the volatility of the exchange rate, as well as dummies for EMU and RTAs. As far as we concern, this is the first article studying jointly these effects.

## II. Methodology: the gravity model

*Baseline empirical model*

We consider the augmented version of the Anderson (1979) model proposed by Anderson and van Wincoop (2003) and, following Egger and Pfaffermayr (2003), we include country pair, importer and exporter fixed effects in the specification. The effect of distance and other time-invariant factors that may affect trade, as sharing a border or a language, have a common colonizer or have been the same country in the past, are already captured by the fixed effects, so it is not necessary to include those variables in the specification. Hence, we end up with the following baseline model:

$$\ln(X_{ijt}) = \alpha_1 \ln y_{it} + \alpha_2 \ln y_{jt} + \beta_{ij} + \beta_i + \beta_j + \lambda_t + \ln \varepsilon_{ijt} \qquad (1)$$

The dependent variable is the logarithm of the volume of exports in constant dollars from country *j* to *i*. ln$y_{it}$ and ln$y_{it}$ are the logarithms of real PPP-converted GDPs in each country; their effect on trade is expected to be positive. $\beta_{ij}$, $\beta_i$ and $\beta_j$ are country pair, exporter and importer fixed effects, and $\lambda_t$ denotes the time effects. Data are collected from several sources, including CHELEM-International Trade database for the export values and GDP, CEPII's database, World Bank data and IFM Statistical Yearbook for prices indexes. Our sample includes 80 countries during the period 1967-2009. The list of countries is provided in the appendix. We estimate equation (1) using panel fixed effect estimators. Gómez-Herrera (2012) provides a review of other estimation methods for this equation.

*Specification with exchange rate variables*

The exchange rate level and ERV are variables affecting international trade via export price; however, articles using cross-section data have not focused on these variables, since they were unable to capture variations in the level of the exchange rate.

Thus, a complete panel data is the appropriate framework to evaluate the effect of exchange rate level on exports. If the Marshall-Lerner condition is fulfilled, which is generally the case when considering long-run elasticities, a real appreciation has a negative impact on exports through a decrease in competitiveness (demand effect) or a comparative increase of profitability of traded good sector against non-traded goods (supply effect). Even when market structures are taken into account (for instance when they give rise to pricing to market strategies), a RER appreciation leads to a worsening of the competitive position of the economy, and consequently to a rise in imports and a fall in exports. This fact is now well documented and it is robust to the use of alternative measurement strategies even if aggregate demand and supply elasticities also depend on the structure of specialization in each country. Thus, it is surprising that so much empirical models do not take into account the real exchange rate.

The impact of ERV on trade is more controversial, both in theory and empirical analysis. In theory, an increase in volatility could either increase or decrease trade, depending on the risk aversion of firms or on the shape of the production functions. Looking at empirical analysis suggests that the measured effects of ERV on trade can be either, very low and little significant or significantly negative though minor in magnitude. McKenzie (1999) points out that the elasticity of trade flows to ERV can be either positive or negative, and the results depend on the precise measure of volatility, on the estimation technique and on the sectors and countries concerned. Its impact actually differs according to the countries under study; Sauer and Bohara (2001) show a negative impact of ERV on African and Latin American exports and a non-significant impact on Asian exports and on developed countries exports. Frankel et al. (1995) evidence a significant negative impact of ERV on trade flows across Asian countries on a cross-section basis. Rose (2000) finds it to be a significant and systematic impediment to trade for an extensive sample of countries. Gil-Pareja et al. (2008) find a statistically

significant negative effect on trade. Tenreyro (2007) develops an instrumental-variable (IV) version of the Poisson Pseudo Maximum Likelihood technique (PPML henceforth) to deal with the endogeneity and the measurement error of exchange rate variability estimator. Results indicate that nominal exchange rate variability has no significant impact on trade flows. Mukherjee and Pozo (2011) analyze the real exchange rate volatility effect on trade estimating a gravity equation using semi-parametric regression methods. They find that large ERV depresses trade, but the impact of uncertainty on trade volume fades as volatility grows.

Taking the previous equation as starting point, we have estimated an additional equation to measure the sensitiveness of exports to exchange-rate regimes:

$$\ln(X_{ijt}) = \alpha_1 \ln y_{it} + \alpha_2 \ln y_{jt} + \alpha_7 \ln rer_{ijt} + \alpha_8 vol_{ijt} + \beta_{ij} + \beta_i + \beta_j + \lambda_t + \varepsilon_{ijt} \qquad (2)$$

where:

$rer_{ijt}$ is the real exchange rate, computed using CPI and defined as the relative price of *j* to *i* (an increase therefore signals a real depreciation of the currency of country *i* compared to *j*).

$vol_{ijt}$ is a measure of volatility, defined as the standard deviation of the rate of change of the volatility of the monthly real exchange rates for a given year t. It is computed as:

$$vol_{ijt} = \sqrt{\text{var}(|\ln rer_{ij\tau} - \ln rer_{ij\tau-1}|)_{\{\tau=1\to12\}}} \qquad (3)$$

where $rer_{ij\tau}$ is the monthly real exchange rate of *j* to *i* for month τ in year t.

*Specifications with RTA and EMU variables*

The next step in our analysis requires the inclusion of four dummies indicating if one or both trade partners have a trade or a monetary agreement. Then, we capture how

the common currency or RTA affects export to countries belonging to the agreement and exports to third countries:

$$\ln(X_{ijt}) = \alpha_1 \ln y_{it} + \alpha_2 \ln y_{jt} + \alpha_6 \ln rer_{ijt} + \alpha_7 vol_{ijt} + \alpha_8 RTAone + \alpha_9 RTAboth + \alpha_{10} EMUone + \alpha_{11} EMUboth + \beta_{ij} + \beta_i + \beta_j + \lambda_t + \varepsilon_{ijt} \quad (4)$$

where:

*RTAone* and *RTAboth* take value one when one or both countries belongs to a RTA, and zero otherwise. We intend to capture possible creation or diversion effects; a positive sign for *RTAboth* would imply that belonging to a RTA has a creation effect while a negative sign for *RTAone* could indicate a diversion effect for exports or imports.

*EMUone* and *EMUboth* take value one when one or both countries respectively belong to the EMU, and zero otherwise. *EMUboth* allows assessing the effect of the EMU on exports inside the eurozone. A positive sign for this variable would indicate a positive effect of the common currency on EMU exports to the eurozone, apart from the effect of the non-tariff regime among these members and once the effect of the elimination of the ERV is controlled for. A positive effect for *EMUone* would indicate that the euro has favoured the exports and imports between the eurozone and third countries.

Finally, in a fourth specification, we disentangle the effect of EMU on the exports and imports of eurozone members. To this end, we replace the variable $EMUone_{ijt}$ by two dummies ($EMUimp_{ijt}$ and $EMUexp_{ijt}$) to distinguish among the cases in which only the exporter or only the importer belongs to the EMU.

$$\ln(X_{ijt}) = \alpha_1 \ln y_{it} + \alpha_2 \ln y_{jt} + \alpha_6 \ln rer_{ijt} + \alpha_7 vol_{ijt} + \alpha_8 RTAone_{ijt} + \alpha_9 RTAboth_{ijt} + \alpha_{10} EMUimp_{ijt} + \alpha_{11} EMU\exp_{ijt} + \alpha_{12} EMUboth_{ijt} + \beta_{ij} + \beta_i + \beta_j + \lambda_t + \varepsilon_{ijt} \quad (5)$$

where $EMUimp_{ijt}$ takes value one if the importer involved in the trade flow belongs to the EMU and zero otherwise. Analogously, $EMUexp_{ijt}$ takes value one when the exporter belongs to EMU and zero otherwise. We are especially interested in the sign of the variable $EMUimp_{ijt}$. A negative sign would imply a diversion effect of EMU; EMU countries would be substituting their imports from the rest of the world by imports of EMU countries. A negative sign for $EMUexp_{ijt}$ would indicate a geographic reallocation of exports of the eurozone members in detrimental of third countries.

**III. Estimation**

We estimate all the different specifications using panel fixed effects. Previous to the estimation we have conducted some specification tests. If unobserved heterogeneity is present, OLS estimation yields biased and inconsistent estimates. Hence, we have tested the existence of fixed effects using Likelihood Ratio (LR) and Lagrange Multiplier (LM) tests on time and individual effects. In both cases, we reject the null hypothesis of no fixed effects. The standard F-test for the joint significance of individual and time dummies confirms our results. We conclude that OLS results are biased and inconsistent, and should not be used as estimation method in this case.

In order to choose between fixed and random effect models, we have performed a Hausman test. Under the null hypothesis, the random effect model is assumed to be consistent and efficient. In all cases we reject the null and conclude that the random effect model is not appropriate; and consequently we use the within fixed effects estimator. We include vectors of fixed effects for exporter, importer and time and we apply the within transformation to each pair of countries. Finally, since the White's

general test in OLS regressions and the modified Wald statistic reveal the presence of heteroscedasticity we compute robust standard errors.

## IV. Impact of EMU on exports

Turning to our results, we first describe briefly the results of our baseline model (specification 1), then analyze the effect of the volatility and level of the RER on exports (specification 2). We then discuss the results of the more complete specification (specification 3) that takes into account the effect of RTA and EMU on exports. We report these results in Table 1.

*Baseline model*

The results for the baseline model are in line with related literature. As expected, both the exporter and importer real GDP increase exports and the estimated coefficients for GDP are close to one, which is the expected order of magnitude.

*Effect of Exchange rate*

Results obtained from the estimation of the specification 2 reveal that the RER has the expected positive sign and a 10 per cent depreciation leads to a 5.1 per cent increase in bilateral exports. This is a rather sensible price-elasticity estimate (working on the G7 countries, and relying on time-series econometrics, Hooper et al. (1998) find the long-run price-elasticity of exports to be ranging between 0.2 and 1.6). In the most complete version of the model (specification 3), RER displays a similar positive sign.

The volatility of the exchange rate has an important detrimental effect on exports, which is significant at the one per cent level. This result implies that if ERV were to rise by one standard deviation, trade would fall by about 5.79 per cent[6]. This result is in line

[6] This interpretation was first proposed by Rose (2000). It consists of reducing volatility by an amount equal to its standard deviation. In our case, the standard deviation of $vol_{ij}$ is 0.115 and the estimate of its

with De Nardis and Vicarelli (2003) who find a reduction of 4.04 per cent, Gil-Pareja et al. (2008): 1.5 per cent, Rose (2000): 13 per cent, or De Grauwe and Skuderlny (2000):16,9 per cent. Unlike Clark et al. (2004) and Gil-Pareja (2008), we find that the negative relationship between volatility and trade is robust when introducing country year fixed effects. Gains from anchoring to one money are assumed to be larger when the elasticity of trade to ERV is higher. Our results confirm that there is potential for an increase in international trade by reducing the volatility of exchange rates. This could be an argument for some developing countries to anchor their currency on the yen, dollar or euro. To the extent that this sensibility calculated for the world average may accurately represents the sensibility of EMU exports to volatility, this allows us to calculate the effect that the elimination of ERV of the old currencies had on EMU exports. Indeed, the volatility among the partners of the eurozone has been of 3.12 per cent before the adoption of the euro. Then, the elimination of the volatility would have led to an increase of 1.33 per cent of EMU exports. This is an important impact but rather far from the optimistic Rose's proposal.

parameter –0.49. Hence, the, the increase in bilateral trade following a reduction of volatility from one standard deviation to zero would be given by [(exp-0.49x(VOL-0.115)/e-0.49xVOL)-1]x100, where VOL is the sample mean of the volatility. The result obtained is 5.79%.

Table 1: From a baseline model to an empirical model to assess EMU effect

| | *Baseline specification* | *Specification 2* | *Specification 3* | *Specification 4* |
|---|---|---|---|---|
| Dependent variable: Logarithm of exports | | | | |
| Log of exporter real GDP | 1.401*** | 1.308*** | 1.276*** | 1.282*** |
| | (0.0488) | (0.057) | (0.058) | (0.059) |
| Log of importer real GDP | 1.277*** | 1.413*** | 1.376*** | 1.370*** |
| | (0.0478) | (0.060) | (0.060) | (0.060) |
| Log of RERij | | 0.051*** | 0.051*** | 0.052*** |
| | | (0.014) | (0.013) | (0.013) |
| RER Volatility | | -0.492*** | -0.447*** | -0.447*** |
| | | (0.064) | (0.063) | (0.063) |
| One partner has RTA | | | 0.214*** | 0.214*** |
| | | | (0.035) | (0.035) |
| Both partners have RTA | | | 0.395*** | 0.393*** |
| | | | (0.034) | (0.035) |
| One partner in EMU | | | -0.058* | |
| | | | (0.030) | |
| EMUimp | | | | -0.086** |
| | | | | (0.042) |
| EMUexp | | | | -0.03 |
| | | | | (0.032) |
| Both partners in EMU | | | 0.165*** | 0.166*** |
| | | | (0.045) | (0.045) |
| Constant | -0.179 | -0.468 | 0.231 | 0.232 |
| | (0.755) | (0.921) | (0.937) | (0.937) |
| R-squared | 0.792 | 0.806 | 0.808 | 0.808 |

*Source:* Authors' own calculation.
*Notes*: * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in parenthesis. All the regressions include country pair fixed effects, importer and exporter specific fixed effects and time effects.

*RTA and EMU effects*

Turning to our most important variable, results in Table 1 confirm that EMU has a positive and significant impact on exports once we control for the presence of trade agreements, RER levels and volatility of the exchange rate. The panel fixed effects estimation concludes that EMU members export 17 per cent[7] more than other countries do. Unlike Clark et al. (2004) and Gil-Pareja (2008), we find that the positive impact of

[7]To interpret dummy coefficients as a percentage change we apply the following transformation to the coefficient obtained: 100*[EXP(α)-1].

RTA is robust to the introduction of country and year fixed effects. This is probably attributed to the fact that our sample contains a higher number of country-pairs having a RTA that does not belong to the eurozone, which allows us to better distinguish among the effects of different kind of agreements.

It is striking that we find evidence of a positive impact of the euro on trade once the elimination of volatility is controlled for. This can improbably be explained only by the elimination of transaction costs. Then, this is an additional proof of the non linear relationship between the volatility of the exchange rate and trade. Baldwin et al. (2005 and 2008) offers an attractive explanation for the fact that the elimination of hedging costs associated with the ERV before the introduction of the euro translates into an extensive increase of trade. Unfortunately, the full verification of this fact would imply to rely on a measure of the intensive and extensive margin of trade, and that issue is beyond the goal of this study.

Trade agreements may also have a diversion effect on trade with third countries by reducing imports, since it artificially reduces the price of imports coming from members. Though, the impact of exports is less clear. We find that belonging to a RTA also has a positive and significant impact on exports to non-members countries. Turning to the effect of EMU on trade with non-members, we find evidence of diversion effect. EMU seems to have reduced imports from third countries. On the contrary, the common currency has not had a significant effect on EMU exports.

## V. Additional results

We have re-estimated the third specification in Table 1 introducing some changes to check the robustness of the results and to bring new elements to the discussion; results are displayed in Table 2.

*Impact of volatility on trade: before versus after the euro*

The introduction of the euro by one country not only limits the volatility of bilateral exchange rate between this country and its trade partners but it also affects the volatility of exchange rate among these third countries. Then, it could be the case that the introduction of the euro changes the overall sensibility of traders to the ERV. To test this hypothesis, we estimate an additional specification in which we introduce a new set of dummies: *VOL67-98* reports the value of volatility for the period 1967-98 and zero otherwise; and *VOL99-09* reports the value of volatility for the period 1999-2009. Results reported in the first column of Table 2 show that the effect of volatility was significantly detrimental to trade before the introduction of the euro but does not have a significant impact after the introduction of the common currency. This is an important result since it points out important collateral effect of the new currency.

*Impact of volatility per period: Euroland versus non euroland*

Of course, the coordination among EU members is not a story that started in 1999. The common policy concerning politics, social, trade and numerous norms of convergence had previously reinforced all the links among members and made transactions among their members less risky. Hence, it could be the case that ERV affected future members' trade in a different manner than it affects other countries. In the second column of Table 2, we have alternatively split each of the volatility variables into three variables. We interact *VOL67-98* and *VOL99-09* with three alternative dummies for the different cases in which one, both or none of the countries belong to EMU. The volatility is detrimental in all cases, though no significant for exports to non EMU countries in the post-euro period.

*The joint effect of RTA and EMU*

Most EMU countries were already members of the same RTA for a long period.

Then, the EMU dummy could be capturing not only the financial and monetary integration of the eurozone but also some progressive deepening in the integration of the common market. In sum, the coefficient of EMU may be overestimated since RTA captures the average effect of very different trade agreements while the EU represents the most integrated region. To be sure this is not the case; in the third column of Table 2 we replace the variables RTA and EMU with three dummies; *RTAboth*EMUboth* that takes value one when both partners joined the EMU for all the period; *RTAboth*EMUone* that takes value one when both partners are members of a RTA (the EU or another agreement) and one of them joined the EMU for all the period; and *RTAboth*noEMU* that takes value one when both partners are members of a RTA but did not join the EMU. We find an additional positive effect derived from joining the EMU that is different from the RTA effect, and this positive effect takes place both if one or the two countries involved in the trade flow belong to EMU.

Table 2: Robustness checks. Specification 3.

| | *Specification 5* | *Specification 6* | *Specification 7* |
|---|---|---|---|
| Dependent variable: logarithm of exports | | | |
| Log of RER | 0.052*** | 0.052*** | 0.076*** |
| | (0.013) | (0.013) | (0.018) |
| RER Volatility | | | -0.456*** |
| | | | (0.062) |
| Vol 67-98, No EMU | | -1.549*** | |
| | | (0.171) | |
| Vol 67-98, One partner in EMU | | -0.929*** | |
| | | (0.205) | |
| Vol 67-98, Both partners in EMU | | -2.681*** | |
| | | (0.956) | |
| Vol 99-09, No EMU | | 0.161 | |
| | | (0.541) | |
| Vol 99-09, One partner in EMU | | -0.045 | |
| | | (0.068) | |
| Vol 67-98 | -1.401*** | | |
| | (0.141) | | |
| Vol 99-09 | -0.023 | | |
| | (0.058) | | |
| One partner has RTA | 0.206*** | 0.203*** | 0.242*** |
| | (0.035) | (0.035) | (0.036) |
| Both partners have RTA | 0.388*** | 0.389*** | |
| | (0.034) | (0.034) | |
| EMUimp | -0.078* | -0.052 | |
| | (0.042) | (0.043) | |
| EMUexp | -0.021 | 0.004 | |
| | (0.033) | (0.034) | |
| Both partners in EMU | 0.198*** | 0.180*** | |
| | (0.046) | (0.046) | |
| RTAboth*EMUboth | | | 0.465*** |
| | | | (0.056) |
| RTAboht*EMUone | | | 0.150** |
| | | | (0.059) |
| RTAboth*noEMU | | | 0.096*** |
| | | | (0.031) |
| Constant | 0.154 | 0.135 | 0.328 |
| | (0.935) | (0.935) | (0.924) |
| R-squared | 0.808 | 0.824 | 0.823 |

*Source:* Authors' own calculation.
*Notes*: * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in parenthesis. Control variables (exporter and importer GDP) are included but not reported for the sake of clarity. All specifications include country pair, exporter, importer and time effects.

### 5.4. Details on the Euro impact

*Euro impact on eurozone trade with other EU members*

In Table 3 we analyze the euro effect on EMU trade with other European countries that do not belong to EMU. The first row reports the euro effect on trade with Denmark, Sweden and UK. Though positive, the effect is not significant nor for exports neither for imports from these countries. The second row provides evidence of the euro effect on EMU trade with CEE countries.[8] Our results are in line with Cieslik et al. (2009), revealing a positive and statistically significant coefficient of this variable, which indicates that it has strongly contributed to the expansion of some CEE countries' exports.

Table 3: The impact of EMU on other EU countries

| | *Exports* | *Imports* |
|---|---|---|
| Dependent variable: logarithm of exports | | |
| EMU - EU15 | 0.02 | 0.032 |
| | (0.067) | (0.058) |
| EMU -EU25 | 0.308*** | 0.311*** |
| | (0.057) | (0.072) |

*Source:* Authors' own calculation.
*Notes:* *** significant at 1%. Robust standard errors in parenthesis. Control variables (Exporter and Importer GDP) are included but not reported for the sake of clarity. All specifications include country pair, exporter, importer and time effects.

*Euro impact on each EMU country*

The analysis for individual EMU members reveals the existence of a good deal of variation in the euro effect across member countries. In the related literature, this impact is found to be particularly high for Spain; see, for example, Gil-Pareja et al. (2005), Baldwin and Di Nino (2006) and Baldwin et al. (2008) or Micco et al. (2003).

Table 4 shows in the first column the impact of EMU on each country when trading with other EMU countries. The second (third) column shows this impact over exports to (imports from) third countries. Our results show a positive and large coefficient for Spain when trading with other EMU countries, followed by Portugal,

[8] Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia.

Italy, Belgium and Luxembourg. This effect is found to be negative and significant for Ireland. Turning to trade with third countries, it is shown that Germany and Ireland have reduced both their exports to and their imports from third countries following the introduction of the euro, whereas for Spain the effect has been positive in both cases.

Hence, it is shown that there are important differences across countries regarding the impact of EMU on trade, and the exercise performed in this section allows us to better understand the aggregated coefficients displayed in Table 1. However, the fact that only four over twelve eurozone members have benefited from an 'extra' gain in terms of trade after controlling for the gains obtained from the elimination of volatility may be explained by conditions shared by all four or by the fact that the effect year by year could differ from one country to another.

Table 4: EMU effect by country

| | *EMUboth* | *EMUexp* | *EMUimp* |
|---|---|---|---|
| Austria | 0.123 | 0.024 | -0.189 |
| | (0.081) | (0.086) | (0.116) |
| Belgium and | 0.322*** | 0.003 | 0.04 |
| Luxembourg | (0.071) | (0.064) | (0.115) |
| Finland | -0.022 | 0.074 | -0.409** |
| | (0.068) | (0.071) | (0.163) |
| France | 0.098 | -0.232*** | -0.137 |
| | (0.074) | (0.069) | (0.087) |
| Germany | 0.032 | -0.309*** | -0.309*** |
| | (0.067) | (0.071) | (0.098) |
| Greece | -0.036 | 0.079 | 0.039 |
| | (0.099) | (0.109) | (0.134) |
| Ireland | -0.358*** | -0.512*** | -0.419*** |
| | (0.073) | (0.096) | (0.110) |
| Italy | 0.275*** | -0.023 | -0.048 |
| | (0.071) | (0.064) | (0.085) |
| Netherlands | 0.045 | -0.046 | -0.02 |
| | (0.065) | (0.064) | (0.088) |
| Portugal | 0.332*** | 0.215** | 0.189 |
| | (0.112) | (0.109) | (0.133) |
| Spain | 0.660*** | 0.130* | 0.271*** |
| | (0.087) | (0.072) | (0.091) |

*Notes*: * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in parenthesis. Control variables (Exporter and Importer GDP) are included but not reported for the sake of clarity. All specifications include country pair, exporter, importer and time effects.

*Euro impact over time*

We estimate the single currency's year-by-year impact to study the euro effect on trade more precisely. Table 5 presents the evolution of the EMU effects over time. It can be appreciated that the euro significantly boosted intra-EMU trade starting in 1999, with the effect reaching its maximum in the 2003-05 period. Micco et al. (2003) perform a similar exercise and their results point in the same direction. However, their sample only includes the 1992-2002 period.

Table 5: EMU impact over time

| | *EMUboth* |
|---|---|
| Dependent variable: logarithm of exports | |
| 1999 | 0.303*** |
| | (0.046) |
| 2000 | 0.192*** |
| | (0.047) |
| 2001 | 0.126*** |
| | (0.048) |
| 2002 | 0.174*** |
| | (0.049) |
| 2003 | 0.262*** |
| | (0.049) |
| 2004 | 0.235*** |
| | (0.049) |
| 2005 | 0.205*** |
| | (0.050) |
| 2006 | 0.131*** |
| | (0.051) |
| 2007 | 0.108** |
| | (0.054) |
| 2008 | 0.034 |
| | (0.054) |
| 2009 | 0.155*** |
| | (0.055) |

*Source:* Authors' own calculation.
*Notes*: * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in brackets. Control variables (Exporter and Importer GDP) are included but not reported for the sake of clarity. All specifications include country pair, exporter, importer and time effects

## Conclusions

We have estimated a gravity equation including the level and the volatility of the real exchange rate, the existence of trade agreements and the euro introduction for a large sample of 80 countries during the period 1967-2009. As far as we know, this is the most complete gravity equation and largest period used to this end in the literature. Compared to other studies, we use a more heterogeneous sample which allows us to confirm some previous results and to add new ones. We confirm that the common currency has had a positive impact on EMU exports to other EMU countries, though it has reduced imports from third countries to the eurozone. In addition, we find that the elimination of exchange rate volatility boosted exports *per se* since our study highlights its detrimental effect on trade. This is not a specificity of the eurozone since our estimations are based on a large sample and a long period. Then, the possibility to peg to the euro could boost third EMU trade to third countries as well as trade between those third countries. On the other hand, EMU countries have clearly loose the possibility to adjust with their exchange rate. Thus one should be cautious when comparing the benefits of the EMU with the gains the countries could obtained from depreciation; this is an important element to take into account.

Besides that, our sensitivity analysis on the volatility impact on trade shows that it was significantly detrimental to trade before the introduction of the euro but it does not have a significant impact after the introduction of the common currency. In addition, we show that exports of EMU countries involved in a RTA are larger than exports of countries involved in another type of RTA. Finally, the analysis of the euro effect for individual EMU members reveals the existence of a good deal of variation in the euro effect across member countries, showing the higher coefficients for Spain, Italy, Portugal, Belgium and Luxembourg. This effect is found to be negative and significant for Ireland. Moreover, we provide evidence that EMU has contributed to the expansion

of some CEE countries exports.

This work can be extended in several directions. First, further research is needed to explain the differences in the euro effect across EMU members. Comparative analysis of the impact of exchange rate on the extensive and intensive margin of trade for several countries could shed more light on the European process, allowing us to have a better understanding of its benefits and disadvantages. Secondly, it would be interesting to analyze the properties of the time series of the panel. The presence of non-stationarities and structural breaks in the data is rather probable given the long run period under analysis and the use of more adequate estimators could improve the conclusions obtained.

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**Appendix A: List of countries included in the sample**

Albania
Algeria
Argentina
Australia
Austria
Bangladesh
Belarus
Belgium and Luxembourg
Bolivia
Bosnia and Herzegovina
Brazil
Brunei Darussalam
Bulgaria
Canada
Cameroon
Chile
Chine
Colombia
Côte d'Ivoire
Croatia
Czech Republic
Denmark
Ecuador
Egypt
Estonia
Finland
France
Gabon
Germany
Greece
Hong Kong
Hungary
India
Indonesia
Ireland
Israel
Italy
Japan
Kazakhstan
Kenya
Kyrgyzstan
Latvia
Libya
Lithuania
Macedonia
Malaysia
Mexico
Morocco
Netherlands
New Zealand
Nigeria
Norway
Pakistan
Paraguay
Peru
Philippines
Poland
Portugal
Romania
Russian Federation
Saudi Arabia
Singapore
Slovakia
Slovenia
South Korea
Spain
Sri Lanka
Sweden
Switzerland
Taiwan
Thailand
Tunisia
Turkey
Ukraine
United Kingdom
Uruguay
USA
Venezuela
Viet Nam