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Has the Euro Increased Trade?

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Abstract

A major economic reason for the introduction of the euro was its supposedly positive effect on intra-EMU trade. Existing studies examine this suspicion indirectly using non-EMU data and report ambiguous results. We estimate the euro-effect directly from data that include EMU observations. Using a dynamic panel model for annual bilateral exports, we find that the euro has significantly increased trade, with an effect of 4% in the first year and cumulating to around 40% in the long-run. These estimates can be useful in the debates on whether to join the euro in countries such as the U.K.

Key words: currency union, dynamic panel data model, EMU, exports, imperfect substitutes model.
JEL classification: C23; F15; F33.

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1 Introduction

A major economic reason for the process towards Economic and Monetary Union (EMU) in Europe was the widespread view that EMU would enhance trade between the participating countries. For instance, the euro would eliminate (nominal) exchange rate risk, making trading profits less risky, so that risk averse traders would increase trade. Moreover, the euro would reduce intra-EMU foreign exchange transactions costs.

Given the importance of the EMU project and the serious costs involved in achieving EMU, many researchers have analyzed the validity of the view that the euro, more precisely EMU, would stimulate trade. Until the introduction of the euro in 1999, however, there was no data on EMU. Authors have therefore used non-EMU data to get an indication of the EMU effect on trade.

The resulting literature can be divided into two parts, based on the type of non-EMU data used. First, numerous studies take data on countries that have floating (or managed floating) exchange rates. They estimate the effect of a reduction of exchange rate volatility on trade and use this to get an idea about the effect of EMU on trade. The results are ambiguous; see the overview paper by McKenzie, 1999, and the many references therein.

The second group of papers using non-EMU data is based on the notion that EMU is more than a reduction of exchange rate volatility. In EMU there is a common currency, so that the nominal exchange rate links are perfectly credible and transactions costs are reduced. Moreover, capital markets are integrated. This may enhance intra-EMU trade. Therefore, several researchers use data on other currency unions to learn about the EMU effect. Glick and Rose (2002), for instance, consider data on currency unions mainly involving developing countries. They estimate that using a common currency leads to an approximately doubling of bilateral trade. However, since the currency unions in their sample involve countries that differ a lot from the EMU countries, they argue that their result may be inapplicable to EMU. The Thom and Walsh (2002) result may be a reflection of this inapplicability, because they find that the currency union between Ireland and the U.K. up to 1979 did not increase trade significantly. Hence, the use of non-EMU data, concerning floating exchange rates and/or other currency unions, has not resulted in a consensus prediction of the effect of the euro on trade.

Now that the euro exists for a few years, one can look at the issue from a different perspective. Instead of predicting the euro-trade effect using non-EMU data, one can now try to estimate it directly by testing for a structural break in trade data involving EMU countries. Hence, the questions we examine in this paper are: has the euro increased trade? And, if so, how large is the effect?

Answers to these questions are useful in various respects. First, evidence of an increase in trade can positively affect the attitude of the public in EMU member states towards the euro. Second, it may help the decisions on joining the euro in Denmark, Sweden and the U.K., the European Union (EU) countries that have so far stayed outside EMU. Third, the issue is relevant for the current negotiations on the accession of central and eastern European countries to the EU and EMU. Finally, since the euro represents an exchange rate fix with the highest level of credibility, a positive effect of the euro on trade may be interpreted as an upper bound for the trade effects induced by less strict exchange rate arrangements, such as currency boards and exchange rate pegs.

In this study we estimate the euro effect on intra-EMU trade by using three years of data on the euro period (1999-2001). More specifically, we have data on annual bilateral exports between the fifteen European Union countries and the G7 countries outside Europe (Canada, Japan and the U.S.) from 1965 through 2001. We estimate the effect of the euro, that is EMU, both through the elimination of nominal exchange rate volatility as well as through the other features of EMU, such as the ones mentioned above. We follow the recent trade literature by using panel data models, though we improve on the usual model specifications, for instance, by accounting for the existence of dynamics in trade flows.

The set up of the paper is as follows. In the next section we provide economic theoretical arguments to determine the choice of variables for the empirical model. In section 3 we present that empirical model. Section 4 reports the estimation results and answers the questions whether and how much the euro has increased trade. Section 5 concludes.

2 Theoretical motivation for empirical model

We focus on real bilateral exports from the domestic to the foreign country and assume they depend on real foreign income, the real exchange rate level and volatility, lagged real exports, and several dummies indicating whether the trading countries participate in EMU or trade integration agreements. This section serves to motivate this assumption and further specifies the relationship, which in itself will form the basis for the empirical model in the next section.

Bilateral export data are recorded on a value basis. Because we have no data on bilateral export prices, we cannot split these values into prices and quantities. Therefore, we take the values and correct them for general price inflation. More specifically, the dependent variable is $EXPORT_{ijt}$, the (logarithm of the) value of exports from

country i (home) to j (foreign) in period t, measured in real (domestic output) terms. That is, it is the nominal export value in domestic currency divided by the price level of domestic output.

To determine which variables are presumably relevant for this variable, we use the following theoretical considerations. First, we take the popular two-country imperfect substitutes model, where domestic exports and goods produced abroad are considered as imperfect substitutes (see Goldstein and Khan, 1985). This model implies that real exports depend on real foreign income and the bilateral real exchange rate (Rose, 1991). We define GDP_{jt} as the (logarithm of) real foreign GDP in period t and RER_{ijt} as the (logarithm of the) bilateral real exchange rate between i and j in period t (domestic output per unit of foreign output).

Second, an important characteristic of trade flows is that there is often a lag between the trade decision and the resulting actual trade flow (Goldstein and Khan, 1985). As Klaassen (1999) shows, this makes the traders foward-looking in two senses. Firstly, traders base their trade decision at time $t-r$ on their idea about the real exchange rate at time t of the actual trade flow. Assuming that the first two moments are sufficient to capture this, the expectation $E_{t-r}\{RER_{ijt}\}$ and variance $V_{t-r}\{RER_{ijt}\}$ of the real exchange rate at time t conditional on information available at $t-r$ are potential determinants of the observed trade flow at time t. Secondly, at $t-r$ the foreign importer needs some indication of the orders he expects from his customers between $t-r$ and t. For simplicity and since the focus of our paper concerns exchange rates and not income, we let foreign income $GDP_{j,t-q}$ at some intermediate time $t-q$ ($q<r$) represent the determinants of that order flow and thus of exports, and we do as if it is known at time $t-r$ (perfect foresight).

The third theoretical consideration behind our empirical model is that trade is inherently dynamic. For instance, if exports were high in the past, then businesses have set up distribution and service networks in the partner country (sunk costs) and foreign customers have grown accustomed to domestic products (habit formation), so that also current exports are high (Eichengreen and Irwin, 1997). Therefore, past exports $EXPORT_{ij,t-p}$ for some lag p are a determinant of current exports $EXPORT_{ijt}$. Note that accounting for dynamics is not common practice in the panel data literature on the effects of exchange rate volatility and/or currency unions on trade. However, because of the economic reasons just given, we prefer to include dynamics. This is empirically supported by Bun and Klaassen (2002), who stress the importance of dynamics in trade studies to avoid biased estimates and standard errors.

The fourth type of export determinant we include concerns the effect of the euro on

trade, which is the focus of the paper. Part of this effect is captured by the real exchange rate variance $V_{t-r}\{RER_{ijt}\}$, because the fixation of nominal intra-EMU exchange rates and the inflation convergence due to the common monetary policy reduce the real exchange rate variance. However, the euro represents more than that. It represents a monetary union, where the exchange rate links are perfectly credible, transactions costs are reduced and capital markets are integrated. This further strenghtens the relations between countries and may intensify trade links. To allow for such extra effects of the euro on trade, we include an EMU dummy EMU_{ijt}, which is one if countries i and j belong to the EMU at time t and zero otherwise; see the appendix for details on the break dates. Such a dummy approach is typically used in the existing literature.

Finally, exports depend on trade integration agreements. Trade has been liberalized over time, particularly among the EMU member states, so that trade is relatively high near the end of the sample period, ceteris paribus. Since the euro affects $V_{t-r}\{RER_{ijt}\}$ and EMU_{ijt} also at the end of the sample period, not correcting for trade integration presumably biases the euro effect on trade upwards. A perfect correction, however, is difficult, because there is no perfect measure for the level of trade integration. As usual in the empirical trade literature, we define several dummies to reduce the omitted variable bias. First, let FTA_{ijt}^{Eur} be one if there is free trade between countries i and j at time t and both countries are in Europe, because of EU or European Free Trade Agreement (EFTA) arrangements; see the appendix for details. Likewise, let FTA_{ijt}^{Am} be one if there is free trade between i and j at time t and both countries are on the American continent, because of the Canada-U.S. Free Trade Agreement or the North American Free Trade Agreement (NAFTA). Third, EU_{ijt} is one if i and j are member of the EU (or European Community (EC)) at time t. Because for EU members both FTA_{ijt}^{Eur} and EU_{ijt} are one, the latter dummy allows for a possible additional effect of EU integration above free trade, originating from the customs union feature of the EU and the deeper cooperation within the EU, for instance.

In summary, real (domestic output) exports are assumed to be a function of lagged real exports, real foreign income, the expected real exchange rate, the variance, and the EMU and trade integration dummies:

$$\begin{aligned} EXPORT_{ijt} &= f_{ijt}(EXPORT_{ij,t-p}, GDP_{j,t-q}, E_{t-r}\{RER_{ijt}\}, V_{t-r}\{RER_{ijt}\}, \\ &\quad EMU_{ijt}, FTA_{ijt}^{Eur}, FTA_{ijt}^{Am}, EU_{ijt}). \end{aligned} \tag{1}$$

If the effect of the euro on trade through the reduction of real exchange rate volatility is positive, then $V_{t-r}\{RER_{ijt}\}$ has a negative effect on trade. If the effect through other EMU features is positive, then EMU_{ijt} has a positive effect. All other variables are expected to have a positive effect on $EXPORT_{ijt}$.

3 Empirical Model

To transform relation (1) into an econometric model we have to make several assumptions. We first specify the conditional real exchange rate mean $E_{t-r}\{RER_{ijt}\}$ and variance $V_{t-r}\{RER_{ijt}\}$. Since it is well-known that it is difficult to beat a random walk based forecasting rule for real exchange rates, we follow that simple rule by specifying $E_{t-r}\{RER_{ijt}\} = RER_{ij,t-r}$.

To proxy the conditional variance $V_{t-r}\{RER_{ijt}\}$, it is common in the literature on the effects of exchange rate volatility on trade to use a measure such as the sample variance in period $t-r$ of the observed real exchange rate changes within that period. For instance, in case of a yearly analysis (as in our study) one typically uses the sample variance over the months in year $t-r$. Taking account of the fact that real exchange rate changes are on average (close to) zero and transforming the monthly variance to the yearly frequency (that is, multiply by twelve), this is approximately equal to the sum of squared monthly real exchange rate changes within year $t-r$. This is an unbiased measure of the unobserved variance. However, the results by Andersen and Bollerslev (1998) demonstrate that one can obtain a better proxy by taking the sum of squared real exchange rate changes over finer subperiods of $t-r$, because this preserves the unbiasedness but is less erratic. We follow that approach by taking the sum of squared real exchange rate changes over all days instead of months in year $t-r$. Therefore, we define annual real exchange rate volatility as $RERVOL_{ij,t-r} = \sum_{d \in D_{t-r}} (RER_{ijd} - RER_{ij,d-1})^2$, where D_{t-r} is the set of days in year $t-r$, and we assume $V_{t-r}\{RER_{ijt}\} = RERVOL_{ij,t-r}$. See the appendix for the construction of daily real exchange rates.

The next type of assumptions regarding (1) concerns the functional form. We assume the function is linear. Because we have panel data, we can allow to some extent for heterogeneity of the functional form across country-pairs ij and time t. Let η_{ij} denote the "individual" effect for country-pair ij. This effect encompasses the impacts of all possible time invariant determinants of trade, such as the distance between both countries, whether the countries share a common language and/or a common border. Likewise, we use a time effect λ_t to capture the time dependence of relation (1). This effect corrects for the impact of all possible country-pair invariant trade determinants, such as the general economic situation in the world and common (for instance, GATT) tariff reductions for all countries. The λ_t also correct for a potential trend in exports that is not explained by GDP.

Relation (1) has unique lag lengths p, q, r. Since the lags are presumably different for different products, and because our export data are aggregated across many

products, we have to allow for a more general lag structure in the econometric model. Furthermore, we use yearly data in the empirical section, so that products for which the lags are less than a year make the contemporaneous values of the regressors relevant. We try to capture both effects by using an Autoregressive Distributed Lag (ADL) type model. For ease of exposition we restrict the lag orders to two, because that will be the preferred specification in the empirical part.

The model thus becomes

$$\begin{aligned} EXPORT_{ijt} = \quad & \alpha + \sum_{p=1}^{2} \gamma_p EXPORT_{ij,t-p} \\ & + \sum_{q=0}^{2} \beta_{1q} GDP_{j,t-q} + \sum_{r=0}^{2} \beta_{2r} RER_{ij,t-r} + \beta_{3r} RERVOL_{ij,t-r} \qquad (2) \\ & + \delta_1 EMU_{ijt} + \delta_2 FTA_{ijt}^{Eur} + \delta_3 FTA_{ijt}^{Am} + \delta_4 EU_{ijt} + \eta_{ij} + \lambda_t + \varepsilon_{ijt}. \end{aligned}$$

We assume a stable dynamic relationship between the dependent variable and the regressors, which implies $\gamma_1 + \gamma_2 < 1$. Since η_{ij} is obviously correlated with lagged exports and since λ_t contains elements such as the general state of the world economy that are correlated with current GDP, we treat η_{ij} and λ_t as fixed instead of random effects. The error term ε_{ijt} in (2) is a zero mean random variable uncorrelated over time and country-pairs, which may exhibit arbitrary heteroskedasticity over time and country-pairs.

The final assumption concerning ε_{ijt} is that it is uncorrelated with the regressors. At first sight, this may be problematic, because countries that trade a lot with each other may be more likely to stabilize their bilateral exchange rate, adopt a common currency, enter into a free trade agreement, and so on. Hence there may be a causality from ε_{ijt} via $EXPORT_{ijt}$ to the regressors. However, we think it is reasonable to ignore this effect. Firstly, insofar as exchange rate stabilization and integration policies depend on the level of exports, it is not so much the contemporaneous value, $EXPORT_{ijt}$, that is relevant, but rather some combination of past, contemporaneous and expected future values. This may reduce the impact of ε_{ijt} on the regressors. Secondly, in our opinion exchange rate stabilization and integration policies do not depend directly on the level of exports, but more on the importance of country j as an export market for country i. This importance is only partly affected by the absolute export level, which further reduces any causality from ε_{ijt} to the regressors. Thirdly, the importance of country j as an export market for country i can be split into the importance of bilateral exports from i to j relative to the multilateral exports of i and the importance of multilateral exports for country i. The first part, concerning the trade shares, seems rather constant over time, so that the regressors depend more on the individual effect η_{ij} than on ε_{ijt}. The

second type of importance raises over time for all countries, reflecting the globalization of the international economy, so that the regressors are more affected by the time effect λ_t than by ε_{ijt}. Fourthly, monetary and trade policies are also affected by cultural and political circumstances, which are unrelated to ε_{ijt}. This is particularly true for EMU, because a major reason for introducing EMU was to get closer to a political union in Europe. In summary, we think that imposing orthogonality between the regressors and ε_{ijt} is reasonable; the empirical results in Dell'Ariccia (1999) are in line with this.

Using the econometric model just described, we can now measure the effect of the euro on trade. As explained in the previous section, this effect goes through two channels. First, the euro (presumably) lowers $RERVOL_{ij,t-r}$. To measure this, we need an indication of the change in volatility that is caused by EMU, denoted by $\Delta RERVOL_{\text{EMU}}$. To estimate that, we take the average realized volatility of real exchange rates between the current EMU countries over the EMU period (so the average $RERVOL_{ijt}$ over all pairs ij of EMU countries and all t from 1999 onwards, denoted by $RERVOL^{\text{1999-2001}}_{\text{EMU countries}}$) and subtract an estimate of the average volatility that would have been relevant for those countries in case there was no EMU. Our estimate is simply the average volatility between the EMU countries before EMU. The before-EMU period is chosen to be five years, and we let $RERVOL^{\text{1994-1998}}_{\text{EMU countries}}$ denote the average pre-EMU volatility (the results of interest in the paper are robust to this choice).[1] This leads to

$$\Delta RERVOL_{\text{EMU}} = RERVOL^{\text{1999-2001}}_{\text{EMU countries}} - RERVOL^{\text{1994-1998}}_{\text{EMU countries}}. \tag{3}$$

To get the effect of the euro through the real exchange rate volatility channel we invert the autoregressive lag polynomial in (2) and multiply the result by the distributed lag polynomial for the real exchange rate volatility variable. For the year of introduction of the euro, 1999, this gives an effect of $\beta_{30} \cdot \Delta RERVOL_{\text{EMU}}$. Because the euro also existed in 2000, the effect is again $\beta_{30} \cdot \Delta RERVOL_{\text{EMU}}$ in that year. However, because of the lagged variables on the right-hand side of (2), there is an additional indirect effect of the introduction of the euro in 1999 on exports in 2000, which is $(\beta_{31} + \beta_{30}\gamma_1) \cdot \Delta RERVOL_{\text{EMU}}$. For 2001 the additional indirect effects on top of $\beta_{30} \cdot \Delta RERVOL_{\text{EMU}}$ are $(\beta_{31}+\beta_{30}\gamma_1) \cdot \Delta RERVOL_{\text{EMU}}$ due to the existence of the euro one year before and $(\beta_{32}+(\beta_{31}+\beta_{30}\gamma_1)\gamma_1+\beta_{30}\gamma_2) \cdot \Delta RERVOL_{\text{EMU}}$ due to its existence

[1] A potential disadvantage is that volatility may have been low from 1999 through 2001 even without EMU, so that simply taking the pre-EMU volatility leads to an overestimation of the volatility reduction caused by EMU. To correct for this, one could multiply $RERVOL^{\text{1994-1998}}_{\text{EMU countries}}$ by the ratio of the average volatility between non-EMU countries within the EU (Denmark, Sweden and the U.K.) during EMU and the average volatility between those countries before EMU. Our data, however, show that this correction ratio is very close to one.

two years before. The cumulative long-run effect is $\frac{\beta_{30}+\beta_{31}+\beta_{32}}{1-\gamma_1-\gamma_2} \cdot \Delta RERVOL_{\text{EMU}}$.

The second channel through which the euro may affect trade goes via the EMU_{ijt} dummy, which changes from zero into one for EMU. The effect in 1999 is δ_1, the cumulative effect in 2000 is $\delta_1 + \delta_1\gamma_1$, and in 2001 it is $\delta_1 + \delta_1\gamma_1 + \delta_1\gamma_1^2 + \delta_1\gamma_2$; the long-run cumulative effect is $\frac{\delta_1}{1-\gamma_1-\gamma_2}$.

The total euro effects for each year then follow by addition of the effects through the volatility and EMU dummy channels.

Because the dependent variable is the logarithm of exports, the effects just computed are not exactly the effects on exports itself, which we are interested in. For that, we compute the relative changes in exports caused by EMU. They follow by taking the exponent of the effects given above and subtracting one.

The purpose of the rest of the paper is to estimate these effects by estimating model (2). A simple estimator is the least squares dummy variable (LSDV) estimator, also called fixed effect or within estimator. It consists of removing the country-pair effects η_{ij} by subtracting country-pair means (within transformation), filtering out the time effects λ_t by subtracting time means, and then applying least squares on the centered variables. For dynamic panel models such as (2) LSDV is known to be inconsistent when the number of time periods is finite and the number of country-pairs goes to infinity (Baltagi, 2001). However, for a sufficiently large number of time periods the bias is small. Bun and Klaassen (2002) show for similar data as in the present study that LSDV indeed yields reasonably accurate estimates and outperforms popular generalized method of moments (GMM) estimators. Hence, we use LSDV here as well.

4 Empirical results

In this section we first describe the data. Then we discuss the estimation results and derive our estimate of the effect of the euro on trade.

An distinctive feature of our data set compared to the data used in other studies is that it includes data over the EMU period, so that we can estimate the euro effect on trade directly. More specifically, we have yearly data from 1965 through 2001 ($T = 37$). We consider all EU countries, Canada, Japan and the U.S.; Belgium and Luxembourg are taken together, because export figures are only available at the Belgium-Luxembourg Economic Union (BLEU) level. This gives 17 countries, so that there are $N = 272$ bilateral export flows. Further details on the data can be found in the appendix.

Table 1 presents the LSDV estimates of the parameters in model (2).[2] Before we come to the euro effects, we briefly discuss the other elements of the model to get an idea of its performance. As expected, lagged exports are an important determinant of current exports. Foreign GDP has the expected positive effect, with a long-run effect of 1.22. The fact that the contemporaneous income effect is higher than the long-run effect, however, is somewhat peculiar in our opinion. The real exchange rate effect is 1.21 in the long-run, and about half of that is achieved within one year. The trade integration dummies also have the expected positive effect. Note that free trade agreements have an economically large effect on trade; in the long-run European countries export twice as much ($\exp(0.71) = 2.03$) to countries with which they have free trade than to other countries. This result is in line with Glick and Rose (2002) and Thom and Walsh (2002). Membership of the EU has a long-run effect of 16% in addition to the free trade effect.

The dynamic model underlying the estimates of table 1 is of order two. To check whether such a lag structure is sufficient to capture the export dynamics, we test for first-order serial correlation in the residuals using a standard LM test. It shows that there is some serial correlation, and only raising the lag-order to at least four leads to an insignificant test (we use a significance level of 5% throughout the paper). However, given that we use yearly data, we are a bit hesitant to use a model with four or more lags. The most relevant question for our paper is whether our results of interest, concerning the impact of the euro on intra-EMU trade, are sensitive to the precise lag structure. Estimation of several models with more than two lags reveals that the focus results, both the point estimates and their standard errors, are robust. Hence, we stick to the second-order model (2).

The impact of the euro on intra-EMU trade goes through two channels (as explained in section 3). First, the euro (presumably) lowers real exchange rate volatility $RERVOL_{ijt}$, and this may affect exports. The estimated effect of volatility on exports follows from table 1. The estimates are mostly insignificant. This is in line with the results from the literature on the effect of exchange rate volatility on trade (McKenzie, 1999). In contrast to our panel data analysis, however, that literature mainly consists of time series studies. A few papers that do use panel data tend to find that volatility depresses trade (for example, Dell'Ariccia, 1999, who also uses data on EU countries). The reason for the difference with our results may be that they use static instead of dynamic panel models, that is, γ_1, γ_2 and all β_{k1}, β_{k2} $(k = 1, 2, 3)$ in model (2) are

[2] The estimates have been computed with the DPD package of Ox (Doornik, Arellano and Bond, 2001).

Table 1: Estimation results for real exports model (2)

		Lag 0	Lag 1	Lag 2	Long-run
$EXPORT_{ij}$	γ		0.73	0.16	
(real exports)			(0.04)	(0.03)	
GDP_j	β_1	1.87	−1.77	0.04	1.22
(real foreign income)		(0.12)	(0.17)	(0.11)	(0.28)
RER_{ij}	β_2	0.56	−0.14	−0.28	1.21
(real exchange rate)		(0.03)	(0.05)	(0.03)	(0.16)
$RERVOL_{ij}$	β_3	−0.17	−0.02	0.54	3.02
(real exch. rate volatility)		(0.28)	(0.22)	(0.27)	(3.70)
EMU_{ij}	δ_1	0.04			0.33
(EMU membership)		(0.01)			(0.10)
FTA_{ij}^{Eur}	δ_2	0.08			0.71
(free trade, in Europe)		(0.01)			(0.08)
FTA_{ij}^{Am}	δ_3	0.05			0.42
(free trade, in America)		(0.01)			(0.11)
EU_{ij}	δ_4	0.02			0.15
(EU membership)		(0.01)			(0.06)

Standard errors in parentheses. Each row contains the estimates for the contemporaneous, one-year, and two-years lagged value of the variable under consideration, followed by its long-run effect on exports. For example, the row labelled GDP gives the estimates of $\beta_{10}, \beta_{11}, \beta_{12}, \frac{\beta_{10}+\beta_{11}+\beta_{12}}{1-\gamma_1-\gamma_2}$, successively.
The standard errors for the long-run effects are computed by the delta-method. All standard errors are robust for arbitrary heteroskedasticity over time and country-pairs.

restricted to zero. Indeed, if we impose that restriction too, we also find a significantly negative effect of volatility on trade. However, as the data clearly reject the restriction, we prefer our estimate that is based on a dynamic model.

Although the estimated volatility effect is insignificant, the results do provide an indication of the magnitude of the true volatility effect. For instance, the 95% confidence interval for the long-run effect is (-4.38, 10.42). It depends on the extent of the volatility change due to EMU whether the width of this confidence interval is a problem for obtaining a sensible answer to the central question of the paper. As explained in section 3, we measure the change in volatility by $\Delta RERVOL_{\text{EMU}}$ defined in (3). Its value appears to be -0.0024. This amounts to a change of -4.9%-points in the yearly real exchange rate standard deviation; the small magnitude can be explained by the fact that exchange rates between the current EMU member states had already been quite stable before EMU. The resulting confidence interval for the percentage long-run

Table 2: Cumulative percentage change in exports caused by the euro

	1999	2000	2001	Long-run	Half-time
$RERVOL$-channel	0.0	0.1	−0.0	−0.7	2008
(exch. rate volatility reduction)	(0.1)	(0.1)	(0.2)	(0.9)	
EMU-channel	3.9	6.8	9.6	38.8	2006
(other EMU features)	(1.2)	(2.1)	(3.0)	(13.6)	
TOTAL EURO EFFECT	3.9	6.9	9.6	37.8	2006
	(1.2)	(2.1)	(3.0)	(13.4)	

The formulae underlying the estimates are given below definition (3). Standard errors obtained from the delta-method are in parentheses; they are robust for arbitrary heteroskedasticity over time and country-pairs. The half-time is the first year in which the cumulative effect is at least half of the long-run effect.

effect on exports is (-2.5%, 1.1%), which points at a small effect in economic terms. The point estimates for the long-run effect as well as the first three EMU years are presented in the first row of table 2. We conclude that the real exchange rate volatility channel of the euro effect on trade is statistically insignificant, and from an economic point of view it is small.

The second channel through which the euro can affect trade concerns the additional effects of EMU besides the volatility reduction, as discussed in section 2. These effects are represented by the change in the dummy EMU_{ijt} from zero to one. Table 1 shows that the estimate for that dummy is significantly positive. To transform this into the economically more meaningful cumulative percentage change in exports, we use the derivation below definition (3). The results are in the middle line of table 2. For example, the effect of the euro on trade via the EMU dummy channel is 38.8% in the long run. Note that this is much larger than any possible effect through the volatility reduction channel.

We can now estimate the total effect of the euro on trade. As the last line of table 2 shows, we find an effect of 3.9% in 1999, and a cumulative effect of 6.9% in 2000, 9.6% in 2001, and 37.8% in the long run. As the corresponding standard errors show, all effects are significant. Hence, we conclude that the euro has indeed increased trade and that the magnitude of the estimated effects is substantial from an economic point of view.

There are three points worth mentioning concerning the long-run estimate. First, how long does it take to reach a given part of the long-run trade benefit? Therefore, we compute the half-time, that is, the first year in which the cumulative effect is at

least half of the long-run effect. This half-time is 2006, so that the gains from EMU come quite fast.

A second issue regarding our long-run estimate of 37.8% is that its standard error is quite large from an economic point of view (13.4%-points). This is partly caused by the few years of EMU data in our sample (only three years). To get some insight into the relevance of the number of years for the estimation accuracy, we recalculate the standard errors for the long-run euro effect using only one and two years of EMU data. For the sample through 1999 we find a standard error of 22.0%-points, whereas the sample through 2000 yields 16.2%-points (for completeness, the point estimates themselves are quite robust). Hence, as expected, having more EMU years seems worthwhile for obtaining more precise estimates.

Finally, we relate our estimates to the conclusions drawn by others. We see that our results are in contrast with the results of Thom and Walsh (2002), as they find no significant effect. One should, however, recall that the currency unions considered are different, because they investigate the Ireland-U.K. link up to 1979 instead of EMU, and that our sample contains more than one fixed bilateral exchange rate, which presumably raises the accuracy of the estimates of interest.

Our results, however, are in line with those reported by Glick and Rose (2002) regarding the significance of the currency union effect. A thorough comparison of the magnitude of our estimate with that of Glick and Rose is hampered by the different modeling strategies (dynamic versus static panel model) and the different types of currency unions examined (EMU versus unions involving developing countries). Nevertheless, some indication can be given. One sometimes views the estimates obtained from static panel models as estimates of long-run effects. Though the validity of such an interpretation is not clear, simulation results based on similar trade data reveal that it can be informative here (see Bun and Klaassen, 2002). Moreover, for the present study a static model leads to an effect of 35.1%, which is close to the long-run effect of 37.8% based on the dynamic model. Hence we compare our long-run estimate to the Glick and Rose estimate of 90% (though Glick and Rose present several higher estimates, we take the 90%, because they prefer that estimate for reasons of conservativeness). Our estimate is substantially lower. The difference is presumably caused by the different types of currency union countries analyzed. In any case, however, the effect on trade is economically sizeable according to both studies.

5 Conclusion

In this paper we have estimated the effect of the introduction of EMU in 1999 on intra-EMU exports. In contrast to the existing literature, our data set includes observations over the EMU period, so that we can provide a direct estimate of the euro effect using euro data. We have used a dynamic fixed effects panel data model to explain annual bilateral exports from lagged exports, GDP, the real exchange rate, its volatility, an EMU dummy and several trade integration dummies. The euro effect can come through two channels, namely the real exchange rate volatility (capturing the nominal exchange rate fixing and inflation convergence) and the EMU dummy (representing other changes, such as the perfect credibility of the nominal exchange rate fix, the reduction of transactions costs and the capital market integration).

We have found that the real exchange rate volatility reduction has a statistically insignificant and economically minor effect on exports (a change in exports of at most a few percent in the long run). This is partly due to the fact that volatility between the current EMU members had already been low before EMU, so that the value added of EMU in this respect is not large. In contrast, the other changes induced by EMU, represented by the EMU dummy, have a clear trade enhancing effect, and this effect is much larger than a possible volatility effect.

We estimate a total cumulative increase in intra-EMU exports of 3.9% in 1999, 6.9% in 2000, 9.6% in 2001 and 37.8% in the long run, where half of the long-run effect will be achieved in 2006. These effects are statistically significant and show that from an economic point of view the euro has a sizeable positive impact on trade. This may, for instance, be relevant in the policy debates on whether to join the euro in Denmark, Sweden and the U.K., and for the negotiations on the accession of central and eastern European countries to the EU and EMU.

Despite the significance of the estimates, their standard errors are substantial from an economic point of view, for instance, 13.4%-points for the long-run estimate. In order to reduce the estimation uncertainty, we have argued that it is useful to update the estimates when more EMU data become available in time. Moreover, even though our dynamic panel data model improves on the models that are typically used in the trade literature, further model and estimation refinements may also improve the accuracy of the estimated euro effect. This is left for future research.

Data appendix

To construct real (domestic output) exports $EXPORT_{ijt}$ we take the logarithm of the sum of monthly real exports, where the latter is the nominal domestic currency value of exports divided by a domestic price index. The numerator is the monthly dollar denominated export value of the IMF Direction of Trade Statistics (DOTS) multiplied by the nominal dollar exchange rate for country i averaged over all days in the month (the daily exchange rates are from Reuters). The preferred domestic price index is the producer price index from the OECD Main Economic Indicators; if unavailable, we take the producer price index from the IMF International Financial Statistics or the consumer price index from the OECD.

Data on GDP_{jt} come from the OECD. The yearly real exchange rate RER_{ijt} is the average of the monthly real rates computed using the nominal rates and price indices mentioned above. The daily real exchange rates underlying the yearly real exchange rate volatility measure $RERVOL_{ijt}$ are derived from the daily nominal rates and linearly intrapolated monthly price indices. All series have been obtained through Datastream, although the DOTS export series had to be extended backwards by DOTS data obtained from the IMF.

The EMU and trade integration dummies are based on the following chronology (obtained from various sources on the internet):

Dec 31, 1966	EFTA tariffs abolished (Aut, Den, Por, Swe, U.K.)
Dec 31, 1967	Fin-EFTA tariffs abolished
Jul 1, 1968	EC customs union completed (BLEU, Fra, Ger, Ita, Nl)
Jan 1, 1973	Den, U.K. left EFTA; Den, Ire, U.K. joined EC
Jul 1, 1977	EC-EFTA free trade
May 1, 1980	Spa-EFTA free trade
Jan 1, 1981	Gre joined EC
Jan 1, 1986	Por left EFTA; Spa-EFTA free trade expired; Por, Spa joined EC
Jan 1, 1986	Fin joined EFTA
Jan 1, 1989	Can-U.S. FTA took effect
Jan 1, 1993	Single European Market completed
Jan 1, 1994	Can-U.S. FTA ended; NAFTA into force
Jan 1, 1995	Aut, Fin, Swe left EFTA and joined EU
Jan 1, 1999	EMU started
Jan 1, 2001	Gre joined EMU

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