IMF Staff Papers
Vol. 46, No. 3 (September/December 1999)

Exchange Rate Fluctuations and Trade Flows: Evidence from the European Union

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This paper analyzes the effects of exchange rate volatility on bilateral trade flows. Through use of a gravity model and panel data from western Europe, exchange rate uncertainty is found to have a negative effect on international trade. The results seem to be robust with respect to the particular measures representing exchange rate uncertainty. Particular attention is reserved for problems of simultaneous causality, stemming from the endogenous behavior of monetary authorities. The negative correlation between trade and bilateral volatility remains significant after controlling for the simultaneity bias. [JEL F14, F17, F31]

One main argument against flexible exchange rates has been that exchange rate volatility could have negative effects on trade and investment. If exchange rate movements are not fully anticipated, an increase in exchange rate volatility, which increases risk, will lead risk-averse agents to reduce their import/export activity and to reallocate production toward domestic markets. This paper provides some estimates of the importance of these effects in the European Union.

The trade issue has played an important role in the debate on the European Monetary System (EMS) and the European Monetary Union (EMU). The EMS was established with the intent of controlling exchange rate volatility and avoiding large

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misalignments among European currencies. One of the stated purposes was to reduce exchange rate uncertainty to promote intra-EU trade and investments. The discussion on the transition to EMU, and in particular the idea of a "two-speed" European Union, where "virtuous" countries would switch to using the euro from the beginning and other countries would join later, involves similar issues. One major concern is that a partial monetary union would have negative effects on the trade flows of the countries joining the single currency at a second stage. The idea is that, as is the case for customs unions, a partial monetary union could divert trade away from nonmember countries. However, there is not strong or unambiguous empirical evidence to support these views. A quite extensive literature has tested the effects of exchange rate regimes on trade, but the results are not always significant and they change across studies.[1] Moreover most papers use only cross-sectional or time-series data instead of a panel, and just a few use bilateral data.

The analysis in this paper includes only Western European countries, allowing gathering of both trade and financial data across time as well as across countries, instead of using cross-sections only. This enables us to deal in a new manner with some of the problems met in the previous literature. There are other reasons to limit the scope of this study to Europe. The theoretical foundations of the gravity model assume identical and homothetic preferences across countries and rely heavily on the concept of intra-industry trade.[2] European countries are relatively homogeneous in terms of technology, factor endowments, and per capita income, so the model seems particularly appropriate for this case. Moreover, as Bayoumi and Eichengreen (1995) note, the relationship between trade and other economic characteristics might be different for industrial and developing countries. Thus restricting the sample to Western European countries minimizes problems due to country-specific factors. Finally, the actual perspective of a single currency regime for the EU makes this set of countries the natural target for this kind of study.

The paper tests the effects of exchange rate volatility on trade using different measures and techniques, with particular attention to the simultaneous causality problem that may arise in these kind of studies. If central banks make an effort to stabilize the exchange rate with their main trade partners, a negative correlation between exchange rate volatility and trade would appear from the data, but this should not be construed to mean that trade reacts negatively to exchange rate instability. The use of panel data facilitates dealing with this problem in a way that explicitly takes into account the behavior of the central banks. If the central bank stabilizing strategy does not change over the period considered, it can be treated as a country-pair specific effect and it can be eliminated by using a fixed-effect model.

[1]For example, Bahmani-Oskooee and Payesteh (1993), Bailey, Tavlas, and Ulan (1986), and Hooper and Kohlhagen (1978), find no evidence of a negative effect of volatility on trade. Wei (1996) in his work on OECD countries finds that volatility coefficients have the wrong sign. Frankel and Wei (1993) and Kenen and Rodrik (1986) find conflicting results. While Kim and Lee (1996), Stokman (1995), Chowdhury (1993), and Perée and Steinherr (1989) find significant evidence of a negative relation. For a discussion see IMF (1984), or European Commission (1990). The existence of conflicting evidence is consistent with Gagnon (1993), who suggests that the likely impact of volatility on trade should be small.

[2]See Helpman (1987).

The empirical evidence in this paper supports the view that exchange rate uncertainty depresses international trade. However, according to the results, the negative effect of exchange rate volatility on trade is very small. The results are robust with respect to the particular measures chosen to represent uncertainty. They also show that the negative correlation between exchange rate volatility and bilateral trade remains significant when one controls for simultaneous causality. However, they reject the hypothesis of the absence of a simultaneity bias.

I. Gravity Models

The gravity model has been widely used in empirical work in international economics.[3] The microeconomic foundations of this model can be directly linked to the theory of trade under imperfect competition, and more specifically to intra-industry trade theory, but the characteristics of this approach are consistent with most theoretical models of trade.[4] In a gravity model the volume of trade between two countries increases with the product of their GDPs and decreases with their geographical distance. The idea is that countries with a larger economy tend to trade more in absolute terms, while distance represents a proxy for transportation costs and it should depress bilateral trade. In general, a per capita income variable is included to represent specialization; richer countries tend to be more specialized, and thus they tend to have a larger volume of international trade for any given GDP level. Models often include a number of dummy variables to control for different factors that might affect transaction costs. For example, a common border, language, or membership in a customs union are suppose to decrease transaction costs and to promote bilateral trade. This paper includes a proxy to represent exchange rate uncertainty. In the actual estimation this variable will take different forms: the standard deviation of the first differences of the logarithmic exchange rate, the sum of the squares of the forward errors, and the percentage difference between the maximum and the minimum of the nominal spot rate. The pooled ordinary least squares (OLS) regression is

$$\log(TRADE_{ijt}) = \gamma_t + \beta_1\log(GDP_{it}GDP_{jt}) + \beta_2\log(DIST_{ij}) + \beta_3\log(pop_{it}pop_{jt}) \\ + \beta_4 BORD_{ij} + \beta_5 EU_{ijt} + \beta_6 LANG_{ij} + \beta_7 v_{ijt} + \varepsilon_{ijt},$$

where *TRADE* is the gross bilateral trade (Exports + Imports) between countries i and j at time t. *EU* represents membership in the European Union (1 when both countries j and i are in the union at time t, 0 otherwise), and *BORDER* and *LANG* represent respectively a common border and language. The variable v represents the proxy for uncertainty about the bilateral exchange rate between country i and j at time t. Note that the intercept has to be allowed to change over time. Indeed, following the model in Helpman (1987), any change in world aggregate GDP will be

[3]See, for example, Bayoumi and Eichengreen (1995), Frankel (1992), and Krugman (1991).

[4]Helpman (1987) uses a Dixit/Stiglitz imperfect competition model to obtain the relation between gross trade and GDPs. Bergstrand (1989) generalizes this model to include Hecksher-Ohlin trade.

captured by the intercept.[5] This implicitly imposes a restriction on the "third-country" coefficient—in other words, assuming, for example, that the trade between Germany and Italy reacts in the same way to a change in U.S. or French incomes.

A major advantage of using panel data is the ability to control for possibly unobservable country-pair individual effects. Such omitted effects, if correlated with the included regressors, would bias the OLS estimation. This papers considers a standard model assuming that the latent individual effect is a time-invariant random variable. That regression reads

$$\log(TRADE_{ijt}) = \gamma_t + \alpha_{ij} + \beta_1\log(GDP_{it}GDP_{jt}) + \beta_2\log(DIST_{ij}) + \beta_3\log(pop_{it}pop_{jt}) + \beta_4 BORD_{ij} + \beta_5 EU_{ijt} + \beta_6 LANG_{ij} + \beta_7 v_{ijt} + \varepsilon_{ijt},$$

where α_{ij} stands for the individual effect. The use of panel data allows one to control for cultural, economical, and institutional country-pair specific factors that are constant over time and are not explicitly represented in the model. Note that in the fixed-effects specification any time-invariant country-pair specific effect will be captured by the dummy α_{ij}.

II. Exchange Rate Volatility Measures

If purchasing power parity (PPP) held, domestic and foreign trade would not systematically involve a different degree of uncertainty. However, exchange rates experience significant and persistent deviations from PPP,[6] adding an exchange risk component to import/export activities. Then an increase in exchange rate uncertainty may lead risk-averse firms to reduce their foreign activity, reallocating production toward their own domestic markets.[7] With regard to this, the relevant type of exchange rate risk will depend on the model of exporting/importing firm that we have in mind. On the one hand, exporting

[5]Assume two differentiated products X and Y, and homothetic preferences identical in every country. Then, in the completely specialized case, imports of country k from country j would be

$$IMP_{kj} = s_k\,(p_x X_j + p_y Y_j),$$

where s_k is country k's share in world spending (and its share of world income in the absence of trade imbalances) and X_j and Y_j are the outputs of goods X and Y produced in country j (the time index is omitted here). The symmetric is true for the imports of country j from country k. Thus the total gross trade is

$$T_{kj} = s_k\,(p_x X_j + p_y Y_j) + s_j(p_x X_k + p_y Y_k) = s_k GDP_j + s_j GDP_k.$$

Rewriting,

$$T_{kj} = s_k s_j GDP_{world} + s_j s_k GDP_{world} = 2GDP_j \frac{GDP_k}{GDP_{world}}.$$

And, when one takes logs, any change in the world GDP will be captured by the constant.

[6]See Froot, Kim, and Rogoff (1995).

[7]This result holds under certain conditions; see De Grauwe (1988). When those conditions are violated, the sign of the elasticity of trade flows with respect to exchange rate volatility is ambiguous. Exchange rate volatility creates a positive option value for firms that have the opportunity to choose whether to sell on the domestic or on foreign markets.

firms may sign short-term export contracts in foreign currency. Then, assuming that costs in the firm's own currency are known at $t – 1$, the only uncertainty arises from the nominal exchange rate: the firm does not know its revenue in domestic currency at $t – 1$.[8] In this situation forward exchange rate markets represent an effective way to hedge against uncertainty. Short-term contracts are available for all the major currencies and they are relatively cheap.[9] On the other hand, firms might have some sort of long term commitment to the export activity. These kind of firms have to sustain sunk costs to enter particular foreign markets and are interested in the relationship between their costs and the price that they can charge on those markets. In this case what matters is the real exchange rate: firms are interested in the evolution of their revenues relative to their costs.[10] To hedge against this kind of uncertainty is much more difficult. Forward markets are not complete in terms of maturity, and the future exchange needs might not be known precisely at the moment of the decision. Hence, real exchange rate uncertainty may play an important role in determining firms' import/export choices.[11]

The first problem in estimating the effects of exchange rate uncertainty on trade is choosing an appropriate variable to represent instability.[12] The literature has used a number of measures of exchange rate volatility and variability as a proxy for risk. Some papers used the standard deviation of the percentage change of the exchange rate or the standard deviation of the first differences of the logarithmic exchange rate.[13] This latter measure has the property of being zero in the presence of an exchange rate that follows a constant trend, and it gives a larger weight to extreme observations (consistently with the standard representation of

[8]The expected utility from profit at time $t – 1$ for the exporting firm will be

$$E_{t-1}U(\Pi_t) = E_{t-1}U((q_t \mid t-1)(p_t^* \mid t-1)e_t - (C_t \mid t-1))$$

where the price in foreign currency is fixed at time $t – 1$, and where, assuming production occurs between $t – 1$ and t, quantity produced and costs are known at time $t – 1$. In this context Viaene and de Vries (1992) show that the effect of exchange rate volatility with well-developed forward markets is ambiguous.

[9]Nonetheless, studies show that only a small, but increasing, part of international trade is actually hedged on forward markets. See Dornbusch and Frankel (1988), and European Commission (1990).

[10]Assuming that costs are a function of domestic prices, for these firms future expected profits are a function of domestic prices, foreign prices, and the exchange rate, thus real profits are a function of the real exchange rate

$$E_0U(\Sigma_t\Pi_t(1 + r)^{-t}) = E_0U(\Sigma_t(p_t^* e_t - C_t(p_t))(1 + r))^{-t})$$

and

$$E_0U\left(\Sigma_t \frac{\Pi_t}{p_t}(1+r)^{-t}\right) = E_0U\left(\Sigma_t \frac{\left(p_t^* e_t - C_t\left(p_t\right)\right)}{p_t}(1+r)^{-t}\right).$$

[11]These considerations suggest that the next step in this kind of study should be to look at more disaggregated data. It seems important to be able to discriminate the effects of exchange rate volatility across industries characterized by different import/export structures.

[12]For a discussion of exchange rate volatility measures, see Brodsky (1984), Kenen and Rodrik (1986), and Lanyi and Suss (1982).

[13]See Brodsky (1984), Kenen and Rodrik (1986), and Frankel and Wei (1993).

risk-averse firms).[14] Others consider the average absolute difference between the previous period forward rate and the current spot to be the best indicator of exchange rate risk. The advantage of this measure is that, under a target zones regime, or under pegged but adjustable exchange rates, it would pick up the effect of the presence of a "peso problem" or the lack of credibility of the official parity. Another possibility is to use the percentage difference between the maximum and the minimum of the nominal spot rate over the *t* years preceding the observation, plus a measure of exchange rate misalignment. This index stresses the importance of medium-run uncertainty. The idea is that large changes in the past generate expected volatility.[15] It is worth noting that the measures proposed as proxies for risk are backward-looking, the assumption being that firms use past volatility to predict present risk. Then, even if one could restrict the choice to a particular measure, there would still be many options: daily, weekly, or monthly changes; which temporal window; etc. Consequently, this paper tests the model using different variables: the standard deviation of the first difference of the logarithmic exchange rate, the sum of the squares of the forward errors, and the percentage difference between the maximum and the minimum of the nominal spot rate.[16] Moreover, it uses different temporal windows, and both real and nominal exchange rates.

A problem of simultaneous causality may arise using some of these measures. Central banks could systematically try to stabilize the bilateral exchange rate with their most important trade partners. In this case exchange rate volatility cannot be treated as an exogenous variable. Exchange rate volatility and trade would be negatively correlated, but the direction of causality would be uncertain, and OLS would provide a biased estimation. In other words, with an OLS regression it would not be possible to distinguish between the effects of investors' risk aversion and the effects of central bank policies. This concern is confirmed by Bayoumi and Eichengreen (1998), who find that monetary authorities are more likely to intervene on the exchange rate when trade links are strong. Instrumental variable estimators represent a solution to this problem. Frankel and Wei (1993) use the standard deviation of the relative money supply as an instrument for the exchange rate volatility. Their justification is that relative money supplies and bilateral exchange rates are highly correlated, but monetary policies are less affected by trade considerations than exchange rate policies. Unfortunately, this solution presents the problem that for many European countries exchange rate stability has been an important determinant of the monetary policy.[17] However, the forward error is not a target of central banks' policies and somehow reflects exchange rate uncertainty. The sum of the squares of the forward errors (defined

[14]The underlying assumption is that a constant trend would be perfectly anticipated and would not affect uncertainty. An alternative variable some authors have used is the standard deviation of the level of the nominal exchange rate. This measure relies on the underlying assumption that the exchange rate moves around a constant level. In the presence of a trend this index would probably overestimate exchange rate uncertainty. For similar measures see Akhtar and Hilton (1984), Bailey, Tavlas, and Ulan (1986), and Hooper and Kohlhagen (1978).

[15]See Perée and Steinherr (1989).

[16]All these variables are constructed using end-of-period exchange rate monthly data from the IMF's *International Financial Statistics* (IFS).

[17]This is especially true for the countries participating in the ERM.

as the difference between the log of the three-month forward rate and the log of the spot rate three months later, using "end-of-the-month" data) is correlated with the standard deviation of the spot rate and thus it represents an instrument for exchange rate volatility.

The availability of panel data allows a different approach to solving the simultaneous causality problem. The idea behind the simultaneity bias is that central banks try to stabilize the bilateral exchange rate against their countries' main trade partners. If that is the case, the exchange rate volatility becomes a function of the share of the bilateral trade between the two countries over their total trade

$$v_{ijt} = \lambda_{ijt} - \beta\left(\frac{T_{ijt}}{T_{i.t}}\right) - \gamma\left(\frac{T_{ijt}}{T_{.jt}}\right) + \eta_{ijt},$$

where the terms β and γ represent the stabilization effort functions of the two central banks. In this context, if the bilateral trade shares were constant over time, one could write

$$v_{ijt} = \lambda_{ijt} + \theta_{ij} + \eta_{ijt}.$$

In that case the central bank factor could be treated as a country-pair fixed effect. Then the central bank effect would be captured by the country-pair dummy, and the fixed effects specification of Regression (2) would give unbiased estimates. One can imagine central banks following a more general and less accurate rule, in which the stabilization effort depends on the order of magnitude of the bilateral shares, and not on their exact value. In such a case the trade shares would not need to be perfectly constant, but only more or less stable over time. In other words, countries would only need to maintain their relative importance as trade partners. This is actually the case for the sample in this paper: trade shares are not strictly constant over time, but for every country the relative size of its trade partners remains more or less the same over the period considered.

III. Empirical Evidence

The sample period covers 20 years from 1975 to 1994. The countries included are the current 15 EU countries (with Belgium and Luxembourg taken as a whole)[18] and Switzerland, for a total of 2,100 observations. The source for the trade data is the OECD database: bilateral data for both import and export flows are available. The GDP data are also from the OECD. The original data were expressed in current prices and different currencies. In order to be used in a multiperiod gravity model they had to be deflated and converted to a common currency.[19] There were two possible ways to proceed. One could first convert the data into a common currency and then use the

[18]Austria, Belgium and Luxembourg, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

[19]For the conversion PPP values from the OECD series were used; very similar results were also obtained by converting all the data to U.S. dollars.

deflator for that currency to express the data in constant prices, or, alternatively, one could first deflate the data with each country deflator and then convert them to a common currency. If PPP applied, the two procedures would be equivalent. However, since PPP often fails, the second procedure seems superior. Indeed, as different countries have different consumption baskets, the second procedure has the advantage of applying the right deflators to each country's data. For similar reasons the paper uses only export data to compute the gross bilateral trade flows.[20] The available export (import) deflators are based on a basket that reflects a country's total export (import).[21] However, with this paper's data the correct deflator should use baskets reflecting the bilateral flows between each pair of countries. It seems reasonable to assume that the bias introduced by using the "aggregate" deflator is smaller for export data than for import data. The idea is that, for each country, the goods it exports to different countries are more homogenous than the goods it imports from different countries. Distances are represented by air distances between capital cities.[22] This paper uses different proxies to represent exchange rate uncertainty: the standard deviation of the first differences of the logarithm of the monthly average bilateral spot rate, the sum of the squares of the forward errors, and the percentage difference between the maximum and the minimum of the nominal spot rate. Exchange rate data are end-of-month observations from the IFS. Analogous measures are used for the real rate that is constructed using CPI indexes from the IFS.[23] The dummy EU is included to control for the progressive enlargement of the union: this variable has value one for country pairs and years for which both countries are EU members. An additional dummy LANGUAGE represents country pairs with a common language.

Table 1 describes the results of Regression (1) using various measures to represent exchange rate uncertainty. The intercept was allowed to change over time and robust standard errors were estimated. All coefficients have the expected sign and are significant at the 1 percent level. Moreover, the results seem to be robust. Most coefficients are similar for the different regressions, suggesting that the four measures of exchange rate uncertainty are in some way equivalent (the regression using the sum of the squares of the forward errors as exchange rate volatility measure is on a subsample of countries that does not include Portugal). It is worth noting the relative importance of having a common language in determining trade flows. Even after controlling for GDP, population, membership in the EU, and a common border, countries speaking the same language trade between each other 24 percent more than those that do not share a common language. The exchange rate volatility coefficient is small, but not irrelevant. From the nominal exchange rate standard deviation coefficient, a total elimination of exchange rate volatility in 1994 would have determined a 12 percent increase in trade,[24] a 13 percent increase using the real exchange rate mea-

[20]Note that, at least in theory, country *j*'s imports from country *k* is equal to country *k*'s exports to country *j*, so import and/or export data could be used to compute the bilateral gross trade.

[21]These are IFS data.

[22]Exceptions are Frankfurt for Germany and Milan for Italy. The source for all distance data is *Alitalia*.

[23]There is no monthly price index for Ireland. The monthly real exchange rate was constructed using the quarterly price index and assuming the inflation rate constant within the quarter.

[24]The average standard deviation of the monthly nominal exchange rate change in 1994 was about 0.55 percent.

Table 1. Regression (1): Pooled Regression

Variable	Nominal Standard Deviation	Real Standard Deviation	Forward Error	Range
GDP	0.94	0.89	0.97	0.93
	(0.026)	(0.026)	(0.039)	(0.028)
POPULATION	–0.20	–0.17	–0.26	–0.19
	(0.029)	(0.029)	(0.041)	(0.031)
DISTANCE	–0.32	–0.32	–0.19	–0.23
	(0.027)	(0.027)	(0.029)	(0.030)
COMMON BORDER	0.27	0.27	0.33	0.29
	(0.017)	(0.017)	(0.018)	(0.021)
COMMON LANGUAGE	0.21	0.22	0.22	0.24
	(0.025)	(0.025)	(0.029)	(0.026)
EU	0.24	0.23	0.34	0.29
	(0.014)	(0.014)	(0.015)	(0.015)
EX. RATE VOLATILITY	–19.52	–21.67	–0.74	–0.87
	(1.204)	(1.219)	(0.076)	(0.105)

Note: All coefficients are significant at the 1 percent level. Standard errors are in parentheses.
Sources: OECD; IFS.

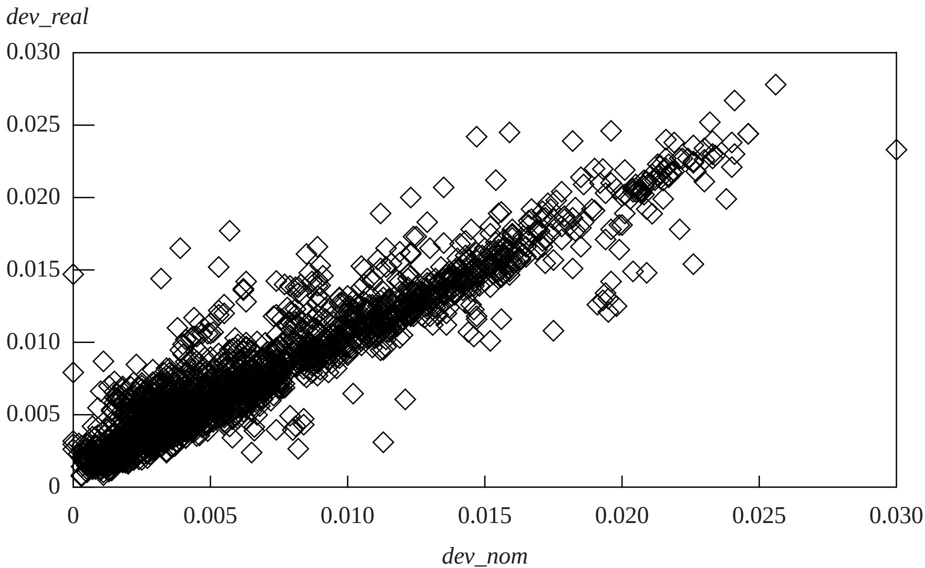
sure, and a 10 percent increase using the forward error.[25] It is interesting to note that the results for nominal exchange rate volatility are very close to the results for real volatility. This outcome is not particularly surprising given that in the sample there is a strong correlation between nominal and real exchange rate volatility (see Figure 1).

The results of Table 1 are statistically significant and seemingly do not depend on the variable chosen to represent exchange rate uncertainty. Nonetheless, the validity of these results could be questioned for the presence of simultaneity bias in Regression (1) when using the standard deviation of the exchange rate change. Central banks are likely to try to stabilize the exchange rate vis-à-vis their main trading partners. In such a case, even if exchange rate uncertainty had no negative effect on trade flows, there would be a negative correlation between exchange rate volatility and trade at a bilateral level. To solve this problem the forward error can be used as an instrument for exchange rate volatility: in particular, the sum of the squares of the three-month logarithmic forward error as an instrument for the standard deviation of the first differences of the logarithmic spot rate. This variable is not controlled by central banks and it is positively correlated with this paper's measure of exchange rate volatility. Note that the forward exchange rate was not available for Portugal, so the regression with instrumental variables uses only a subsample of 14 countries (1,820 observations).[26] Also here the constant

[25]This compares with an average bilateral trade annual growth rate of 3.5 percent for the sample period.

[26]For all the other countries it was possible to construct a forward rate using short-term interest rates. The source was IFS.

Figure 1. Real and Nominal Exchange Rate Volatility
(as from Standard Deviation of Exchange Rate Change)



was allowed to change over time and errors were estimated controlling for heteroscedasticity and autocorrelation.

Table 2 describes the results of the regression using instrumental variables (two-stage generalized least squares) and the results of the standard regression on the same countries (without Portugal). All coefficients still have the right sign, they are significant at the 1 percent level, and their size does not change with respect to the results of Table 1. For the instrumental variable estimation the results are more or less the same, suggesting that the negative correlation between exchange rate volatility and trade is not determined solely by the simultaneous causality bias. In other words, the negative correlation between exchange rate variability and trade does not depend, or at least does not depend entirely, on central banks' policies.

It is possible to test the null hypothesis of absence of simultaneous causality using a Hausman specification test. If the hypothesis is verified, OLS are unbiased and consistent, but they are biased in the presence of simultaneous causality, while the instrumental variable (IV) estimator is unbiased and consistent under both the null and the alternative hypothesis. From the results of the Hausman test we can reject at the 10 percent level the hypothesis that the estimator in Table 1 is unbiased. This result is thus consistent with the presence of a simultaneity bias. Nevertheless, the results obtained with the instrumental variable estimation are still valid and confirm the existence of a negative relation between bilateral exchange rate volatility and trade flows.

The existence of unobserved country-pair specific effects may bias the results of Regression (1). Then, to further test the robustness of these findings, one can use the simple model proposed in Section II. In the fixed effect model any individual

Table 2. Regression (1): Instrumental Variables

Variable	Nominal	Nominal IV	Real	Real IV
GDP	1.04	1.03	0.98	0.98
	(0.033)	(0.034)	(0.034)	(0.035)
POPULATION	–0.32	–0.31	–0.28	–0.27
	(0.036)	(0.036)	(0.036)	(0.037)
DISTANCE	–0.30	–0.30	–0.29	–0.30
	(0.030)	(0.032)	(0.030)	(0.032)
COMMON BORDER	0.28	0.28	0.29	0.29
	(0.019)	(0.020)	(0.019)	(0.020)
COMMON LANGUAGE	0.22	0.22	0.22	0.23
	(0.024)	(0.023)	(0.024)	(0.024)
EU	0.27	0.26	0.27	0.27
	(0.015)	(0.016)	(0.015)	(0.017)
EX. RATE VOLATILITY	–20.36	–21.47	–21.32	–22.17
	(1.295)	(2.147)	(1.327)	(2.210)

Note: All coefficients are significant at the 1 percent level. Standard errors are in parentheses. Reduced sample excluding Portugal.

Sources: OECD; IFS.

effect will be captured by the country-pair dummy. Then, to the extent that the trade shares are stable over time, the fixed effect estimator will also take care of the simultaneity bias.[27] The "central bank effect" has to be constant over time in order to be captured by the country-pair specific dummies. This paper considers both fixed-effect and random-effects estimations. The random-effect model has the obvious advantage of allowing the estimation of the coefficients of time-invariant variables. However, if individual effects are not drawn from the same distribution, the random effect estimates are not consistent. Table 3 reports the results of Regression (2).

In Table 3 the sample is the complete set of 15 countries for the first four columns and the subset without Portugal for the regression with the forward errors. These results seem to confirm the previous findings. The GDP and population coefficients have the right sign and are still positive at the 1 percent level with all three measures of exchange rate volatility. The *EU* dummy coefficient is positive and statistically significant at the 1 percent level.

The Hausman test rejected the unbiasedness of the random-effect estimator at the 5 percent level. Hence, the random-effect coefficients could be biased, and one should rely solely on the fixed-effects estimator. However, the main focus of this

[27]Trade shares are very stable in the sample. The only big change is in Spain/Portugal share. For each country, trade partners were ranked by their share in the country's total trade and then the rankings for 1975 and 1994 were compared. They were very similar for all countries. The overall average place change between rankings was 0.9 places. No change had taken place in 42 percent of the cases, and the maximum change had been five places.

Table 3. Regression (2): Random and Fixed Effects Estimations

Variable	Nominal Standard Deviation Random Effects	Nominal Standard Deviation Fixed Effects	Real Standard Deviation Random Effects	Real Standard Deviation Fixed Effects	Forward Errors Random Effects	Forward Errors Fixed Effects
GDP	1.27*	1.69*	1.25*	1.64*	1.19*	1.41*
	(0.062)	(0.098)	(0.062)	(0.098)	(0.075)	(0.105)
POPULATION	–0.50*	–0.66*	–0.48*	–0.67*	–0.42*	–0.49*
	(0.068)	(0.132)	(0.068)	(0.132)	(0.079)	(0.138)
DISTANCE	–0.07	—	–0.08	—	–0.16	—
	(0.094)	—	(0.094)	—	(0.106)	—
BORDER	0.36*	—	0.36*	—	0.35*	—
	(0.073)	—	(0.072)	—	(0.081)	—
LANGUAGE	0.19**	—	0.19**	—	0.18***	—
	(0.093)	—	(0.093)	—	(0.102)	—
EU	0.15*	0.14*	0.15*	0.14*	0.14*	0.13*
	(0.009)	(0.010)	(0.010)	(0.010)	(0.011)	(0.012)
EX. RATE VOLATILITY	–3.21*	–2.84*	–4.68*	–4.15*	–0.27*	–0.25*
	(0.616)	(0.608)	(1.384)	(0.645)	(0.034)	(0.034)

Note: One asterisk signifies significance at the 1 percent level; two at the 5 percent level; three at the 10 percent level.

Sources: OECD; IFS.

paper is on the exchange rate volatility coefficient that is very similar for fixed-effect and random-effect estimations. The exchange rate volatility coefficient is still negative. It is significant at the 1 percent level for all three different measures and for both fixed-effect and random-effect estimations. However, according to these estimates the size of the effect of volatility on trade is very small. A total elimination of exchange rate volatility in 1994 would have increased trade only by 3 or 4 percent (equivalent to the average annual growth rate of bilateral trade in the sample). Nevertheless, these results are consistent with the idea that a negative correlation between exchange rate volatility and trade exists and that at least a part of it is not spurious correlation caused by central bank stabilization policies. They also suggest that country-specific effects play an important role, advising against the use of pooled OLS estimations.

To test the efficacy of this method in eliminating simultaneous causality, a Hausman test was performed. Also in this case the instrumental variable was represented by the forward error measure. The test could not reject the hypothesis of unbiasedness of the OLS fixed-effect estimator. The result is then consistent with the assumption that the central banks factor is stable over time and is eliminated by using the fixed-effect model.

As noted earlier there is no “right” measure of exchange rate volatility. Accordingly, this paper further tests the robustness of the previous results using a different time window for the measures. Table 4 reports the results of Regression (1) using a two-year window to compute the various exchange rate volatility variables. The results are consistent with the previous ones, confirming a negative effect of volatility on trade. Note that an instrumental variable estimation is used given the outcome of the Hausman test on the previous results. All coefficients have the expected sign and are significant at the 1 percent level.

Finally, some analysis is conducted on the effects of third-country volatility on trade; for example, what happens to trade flows between France and Italy when the volatility between the franc and the deutsche mark increases? However, multicollinearity problems meant that the contribution of third-country volatility could not be isolated. As in Wei (1996), the coefficient was not significant and had the wrong sign.[28]

The evidence in this section shows a negative correlation between exchange rate volatility and trade flows. With the results presented here the hypothesis that the behavior of the central banks has no role in determining the negative correlation between volatility and trade can be rejected. However, the results of estimations that are robust to simultaneous causality bias support the hypothesis that firms, reacting negatively to volatility on foreign currencies markets, determine a decrease in the volume of international trade when the exchange rate becomes more volatile.

IV. The ERM Effect

Most observers viewed the 1992/93 crisis of the EMS (or more precisely, of the Exchange Rate Mechanism) as a stop in the process of economic integration of the European countries. The purpose of the EMS was to reduce exchange rate volatility among member currencies to promote trade and economic convergence, and the ERM was actually successful in reducing both nominal and real exchange rate volatility (this is especially true for the period 1987–92).[29] Thus, following the results from the previous section, the ERM should have had a positive effect on the bilateral trade between EU member countries. If the end of the ERM meant a diminished exchange rate stability, a reduction in intra-EU trade could be expected. In this section the framework presented in the previous sections is used to try to estimate the effects of

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[28]A variable representing the exchange rate volatility of the two currencies with respect to all the others was included

$$\log(TRADE_{ijt}) = \gamma_t + \alpha_{ij} + \beta_1\log(GDP_{it}GDP_{jt}) + \beta_2\log(DIST_{ij}) + \beta_3\log(pop_{it}pop_{jt}) + \beta_4 BORDER_{ij} + \beta_5 EU_{ijt} + \beta_6 LANG_{ij} + \beta_7 v_{ijt} + \beta_8 m_{ijt} + \varepsilon_{ijt},$$

where $m_{ijt} = \Sigma_{i \neq j} v_{ijt} w_{ijt} + \Sigma_{j \neq i} v_{ijt} w_{ijt}$, with weights w_{ijt} represented by relative GDPs. If the trade diversion hypothesis is valid the sign of β_8 should be negative. Table 5 reports the results for Regression (4) with real and nominal exchange rate volatility. Most coefficients have more or less the same values as in Regression (1). However, for both cases there is probably a multicollinearity problem. The correlation between the bilateral exchange rate volatility and the volatility with the rest of the countries in the sample is above 0.9. Then it is not possible to determine the contribution of the two variables separately. Indeed, the "third country" volatility coefficient is not significant and has the wrong sign.

[29]See, for example, Figure 2. For a detailed analysis see De Grauwe and Verfaille (1988).

Table 4. Regression (1): Two-Year Window

Variable	Nominal IV	Real IV	Forward Error
GDP	1.02 (0.038)	0.95 (0.040)	0.94 (0.040)
POPULATION	–0.29 (0.040)	–0.24 (0.041)	–0.23 (0.042)
DISTANCE	–0.36 (0.037)	–0.35 (0.036)	–0.22 (0.032)
COMMON BORDER	0.24 (0.022)	0.25 (0.022)	0.29 (0.021)
COMMON LANGUAGE	0.25 (0.026)	0.25 (0.026)	0.24 (0.026)
EU	0.25 (0.019)	0.26 (0.019)	0.34 (0.016)
EX. RATE VOLATILITY	–13.01 (1.311)	–13.12 (1.324)	–0.46 (0.046)

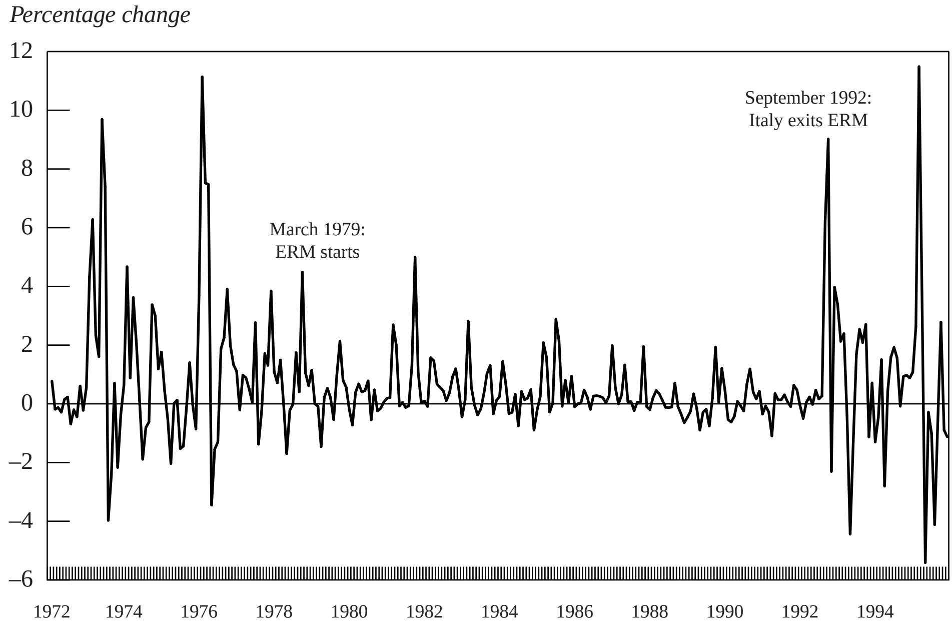
Note: All coefficients significant at the 1 percent level. Standard errors are in parentheses.
Sources: OECD; IFS.

Table 5. Regressions (4): The "Third Country" Effect

	Nominal Standard Deviation		Real Standard Deviation	
Variable	Random Effects	Fixed Effects	Random Effects	Fixed Effects
GDP	1.27* (0.062)	1.69* (0.099)	1.25* (0.062)	1.64* (0.098)
POPULATION	–0.50* (0.068)	–0.66* (0.132)	–0.48* (0.068)	–0.67* (0.132)
DISTANCE	–0.07 (0.095)	— —	–0.08 (0.095)	— —
BORDER	0.36* (0.073)	— —	0.36* (0.073)	— —
LANGUAGE	0.19** (0.094)	— —	0.19** (0.094)	— —
EU	0.15* (0.010)	0.14* (0.010)	0.15* (0.010)	0.13* (0.010)
EX. RATE VOLATILITY	–3.22* (0.617)	–2.85* (0.609)	–4.70* (0.651)	–4.17* (0.646)
"THIRD-COUNTRY" VOLATILITY	–0.24 (0.451)	–0.13 (0.444)	–0.37 (0.468)	–0.27 (0.462)

Note: One asterisk signifies significance at the 1 percent level; two at the 5 percent level; three at the 10 percent level. Standard errors are in parentheses.
Sources: OECD; IFS.

Figure 2. Lira/Deutsche Mark Exchange Rate Volatility with and without ERM



the ERM on trade. A dummy was constructed equal to 1 for pairs in which both countries are members of the ERM and 0 otherwise.[30] The resulting equation is

$$\log(TRADE_{ijt}) = \gamma_t + \alpha_{ij} + \beta_1\log(GDP_{it}GDP_{jt}) + \beta_2\log(DIST_{ij}) + \beta_3\log(pop_{it}pop_{jt}) + \beta_4 BORD_{ij} + \beta_5 EU_{ijt} + \beta_6 LANG_{ij} + \beta_7 ERM_{ijt} + \varepsilon_{ijt}.$$

In this way the ERM dummy captures the stabilizing role that the ERM had on the currencies of member countries. On the other hand, if one is interested in the effect that the ERM had per se, not only through the reduction of exchange rate volatility, the equation becomes

$$\log(TRADE_{ijt}) = \gamma_t + \alpha_{ij} + \beta_1\log(GDP_{it}GDP_{jt}) + \beta_2\log(DIST_{ij}) + \beta_3\log(pop_{it}pop_{jt}) + \beta_4 BORD_{ij} + \beta_5 EU_{ijt} + \beta_6 LANG_{ij} + \beta_7 ERM_{ijt} + \beta_8 v_{ijt} + \varepsilon_{ijt}.$$

A negative sign on the *ERM* dummy coefficient would mean that the mechanism's role in reducing uncertainty went beyond the induced reduction in volatility.

The results of both regressions are presented in Table 6. All the usual coefficients still have the right sign and are still significant. The *ERM* coefficient has the wrong sign. For the fixed-effect model it is significant at the 5 percent level when

[30]This approach has the advantage of avoiding the simultaneous causality problem. The decision to enter the ERM concerns a country's general policy more than simply its trade policy.

Table 6. Regressions (3a) and (3b): The ERM Effect

Variable	Nominal Standard Deviation		Real Standard Deviation		Forward Errors		ERM Only	
	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects
GDP	1.27*	1.71*	1.24*	1.66*	1.19*	1.44*	1.33*	1.72*
	(0.062)	(0.099)	(0.061)	(0.099)	(0.075)	(0.106)	(0.066)	(0.099)
POPULATION	–0.50*	–0.66*	–0.47*	–0.67*	–0.43*	–0.50*	–0.55*	–0.64*
	(0.067)	(0.132)	(0.067)	(0.132)	(0.078)	(0.138)	(0.072)	(0.133)
DISTANCE	–0.08	—	–0.09	—	–0.16	—	–0.03	—
	(0.093)	—	(0.092)	—	(0.105)	—	(0.107)	—
BORDER	0.36*	—	0.35*	—	0.35*	—	0.37*	—
	(0.071)	—	(0.071)	—	(0.079)	—	(0.084)	—
LANGUAGE	0.19**	—	0.19**	—	0.18***	—	0.19***	—
	(0.091)	—	(0.090)	—	(0.100)	—	(0.107)	—
EU	0.15*	0.14*	0.15*	0.14*	0.15*	0.14*	0.15*	0.14*
	(0.010)	(0.010)	(0.010)	(0.010)	(0.012)	(0.012)	(0.010)	(0.010)
EX. RATE VOLATILITY	–3.31*	–2.96*	–4.88*	–4.36*	–0.27*	–0.26*	—	—
	(0.620)	(0.610)	(0.657)	(0.649)	(0.034)	(0.034)	—	—
ERM	–0.01	–0.02**	–0.02**	–0.02**	–0.02**	–0.02**	–0.01	0.02***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.10)	(0.10)

Note: One asterisk signifies significance at the 1 percent level; two at the 5 percent level; three at the 10 percent level. Standard errors are in parentheses.

Sources: OECD; IFS.

controlling for exchange rate volatility, and at the 10 percent level when alone. For the random-effect estimation it is significant at the 5 percent level in the regression with the real volatility measure and with the forward-errors measure. It is not significant in the regression with nominal volatility and when alone. On the one hand, this result seems surprising and conflicts strikingly with the findings in Section III. Indeed, ERM membership should decrease uncertainty and thus increase trade. On the other hand, a large literature addressed the issue of the credibility of the ERM and rejected the full credibility hypothesis for most cases.[31] From that point of view, the result in this section can be reconciled with those in the rest of this paper. If, for most periods and countries, the exchange rate target zones were not credible, one should not expect a significant effect of the ERM dummy on trade flows. At the same time, a non-credible ERM would generate expectations of relatively large realignments, to which agents might react particularly negatively.[32] In other words,

[31]See Giovannini (1990), Svensson (1991), and Frankel and Phillips (1992).

[32]A way to address this issue might be to control for the credibility of the bilateral target zones and construct a "credible ERM" dummy. One would first have to define a measure of credibility, and then could construct a variable taking the value 1 when the commitment to the bilateral parity is credible, and 0 otherwise. The quoted literature relies on tests based on forward rates (or interest rate differentials) first proposed in Svensson (1991). The basic idea is that if the forward rate is outside the band, the target zone cannot be fully credible.

agents might find a system of discrete changes, that are typically large over a short period, more harmful than similar, but more gradual changes under a system of flexible rates.

An alternative, but not very appealing, explanation is provided by political economy. Brada and Mendez (1988) suggest that countries with fixed exchange rate regimes are more likely to use trade restrictions to defend their trade balance. They find some evidence that countries with fixed rates trade less than countries with floating rates. However, in our context this effect seems very unlikely because most countries in the sample (all countries in the ERM) are EU members.

V. Conclusions

This paper tests the relationship between exchange rate uncertainty and trade with data from Western European countries. The analysis uses different variables as proxies for uncertainty, all of which gave consistent results. There was evidence of a small but significant negative effect of bilateral volatility on trade.

The problem of a possible simultaneity bias was addressed in two different ways, and both instrumental variables and fixed effects over time gave results consistent with the hypothesis of a negative effect of exchange rate uncertainty on trade. Nevertheless, a Hausman specification test rejected the hypothesis that no simultaneity bias exists.

Further research in this area should look at more disaggregated data. It is more difficult to find financial instruments to hedge against exchange rate risk when the time horizon becomes longer. Then EMU might have a different impact across industries. In sectors where the export activity requires large investments, trade should prove more sensitive to exchange rate volatility than in sectors characterized by "short-term" exports.[33] For the same reasons, exchange rate stability might be more important for foreign direct investments than for trade flows.[34]

Appendix I. EU-EMS Chronology

Apr. 1951	European Coal and Steel Community—Treaty of Paris
Mar. 1957	European Economic Community—Treaty of Rome (6 countries)
Aug. 1971	End of the Bretton Wood System
Mar. 1972	Introduction of the Snake (Belgium, France, Germany, Italy, Netherlands)
May 1972	Denmark, the UK, and Norway join the Snake.
Jun. 1972	Denmark and the UK exit the Snake.
Oct. 1972	Denmark rejoins the Snake.
Jan. 1973	Denmark, Ireland, and the UK become members of EEC
Feb. 1973	Italy exits the Snake.
Jan. 1974	France exits the Snake.
Jul. 1975	France rejoins the Snake.

[33]Stokman (1995) uses disaggregated, but not bilateral, data to estimate the effects of exchange rate volatility on the intra-EU exports of five European countries.

[34]See Campa and Goldberg (1995) or Goldberg and Kolstad (1995) for some evidence on the relationship between exchange rate volatility and foreign direct investment.

Mar. 1976	France exits the Snake.
Mar. 1979	EMS starts (Belgium, Denmark, France, Germany, Ireland, and Netherlands with 2.25 percent margins, Italy with 6 percent).
Jan. 1981	Greece joins EEC.
Jan. 1986	Portugal and Spain join EEC.
Jun.1989	Spain joins the EMS with 6 percent margins.
Jan. 1990	The margin for the Italian lira is narrowed to 2.25 percent.
Oct. 1990	Unification of Germany. The UK joins the ERM with 6 percent margins.
Feb. 1992	Maastricht Treaty on European Union.
Apr. 1992	Portugal joins ERM with 6 percent margins.
Sep. 1992	Italy and the UK suspend participation in the ERM.
Jan. 1993	Single European Market.
Aug. 1993	ERM margins widened to 15 percent.
Jan. 1995	Austria, Finland, and Sweden join the EU.

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