THE IMPACT OF EMU ON REAL EXCHANGE RATE VOLATILITY OF EU COUNTRIES[1]

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Abstract: There is only a sparse literature on the determination of real exchange rate volatility, and little attention has been given to the possible impact of EMU on volatility of real exchange rates of EU countries. A number of papers suggest a negative impact of exchange rate volatility on investment or growth, for advanced as well as developing countries, although we note that price and wage adjustment that might impact on real exchange rate volatility is also part of the adjustment mechanism to macroeconomic shocks in EMU. We assess whether an effect of EMU on conditional volatility of real effective exchange rates can be detected, both for EMU and non EMU members. We find that the advent of EMU was accompanied by a reduction in real exchange rate volatility for most EMU countries, as well as Sweden and Denmark that did not join EMU, but did not lead to a reduction in real rate volatility for Germany, Belgium, the Netherlands, nor, outside EMU, for the UK.

Keywords: EMU, real exchange rate volatility, GARCH, panel estimation.

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1 Introduction

Within the rather sparse literature on real exchange rate volatility, there has been virtually no work to date on the impact of EMU on the real exchange rate volatility of its component countries and close competitors in the EU. The effect is not self-evident since EMU, while fixing nominal exchange rates within the bloc, could entail more than offsetting rises in the volatility of relative inflation and in the external volatility of the Euro.[2] The former could be of particular importance given the need for domestic price adjustments to offset changes in intra EMU competitiveness, as noted inter alia by Deroose et al (2004). Real exchange rate volatility has in turn been shown to be a major determinant of growth in recent work for developing and advanced countries.

In this paper, we first survey extant work on determinants of exchange rate volatility, most of which use unconditional measures of volatility, and comment briefly on work highlighting its macroeconomic impact. We then investigate conditional volatility of EU countries' real effective exchange rates and assess whether EMU has played a role in reducing it, first by estimating GARCH equations for conditional real exchange rate volatility, and then by testing in a panel framework for determinants of changes in the level of conditional volatility over time, with a key focus on the sign, size and significance of an EMU dummy, while taking into account macroeconomic determinants.

2 Determinants of real exchange rate volatility

As noted by Aghion et al (2006), there is only a small literature on macroeconomic causes of real exchange rate volatility. For OECD countries Hau (2002) found a negative effect of trade openness on unconditional volatility[3] of the real effective[4] exchange rate (REER), which is justified theoretically by the so-called exchange rate magnification effect of nontradeables, according to which a large exchange rate change is needed to restore money market equilibrium after a monetary shock. Meanwhile volatility is reduced by central bank independence and fixed exchange rate regimes. He also finds in a wider panel a negative effect of per capita GDP (richer countries have more stable real exchange rates).

Haussmann et al (2006) again found that lower income countries (measured by the the level of GDP per capita) have more volatile real effective exchange rates, and this is partly related to greater persistence of shocks to the variance of real exchange rate volatility (conditional and unconditional[5]). They also find other proxies for development such as rule of law have a negative and significant effect on exchange rate volatility, as does the degree of export diversification, although most of the differences between low and high income country volatility could not be explained with standard macroeconomic variables.

Bravo and di Giovanni (2005) showed that unconditional[6] real exchange rate volatility is positively correlated with an index of remoteness, defined as weighted geographical distance from main trade centres. Carrera and Vuletin (2002) used not only openness and GDP growth but also terms of trade shocks, capital account shocks, M2 shocks and government consumption as control variables in a 64-country assessment of the effect of exchange

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[2] There have clearly been substantial changes in the levels of real competitiveness in the Eurozone, as highlighted by Lane (2006), with countries such as Ireland facing declines in "intra EMU" real competitiveness of 11% over 1999-2004, and a 21% loss "extra EMU".

[3] Measured as the standard deviation of the monthly percentage change of the REER over a 36 month period.

[4] As noted by Bagella et al (2004), measuring volatility using the real effective exchange rate is a better approach than using a key bilateral real rate (such as the dollar or euro) to assessing exchange rate risk as it trade-weights the volatility of individual bilateral rates, which may themselves be offsetting.

[5] Conditional volatility was measured using ARCH, while unconditional volatility was defined as the standard deviation of the growth rate of the REER.

[6] Defined as the standard deviation of annual changes in the REER.

regimes on unconditional[7] real effective exchange rate volatility. In contrast to Hau (2002), they found that there is more real exchange rate volatility in fixed nominal regimes than in flexible ones. Growth and positive terms of trade changes reduce real rate volatility while acceleration in capital inflows increases it, as do monetary and public finance shocks. Most of the results derived from developing countries.

Devereux and Lane (2002) looked cross sectionally at bilateral unconditional[8] exchange rate volatility, a key component of real exchange rate volatility and find that in developing countries volatility is reduced by external financial liabilities (due to this affecting the choice of regime), as external debt tightens financial constraints and reduces the efficiency of the exchange rate in responding to external shocks. For developed countries it is optimal currency area variables such as trade interdependence (negatively), business cycle asymmetry as well as country size (positively) that determine bilateral volatility. Internal financial development increases volatility for advanced countries and reduces it for developing ones.

As regards the motivation of such work, the traditional view is that there is little effect of real exchange rate volatility on growth, and there is a "disconnect" with the real economy (Devereux and Engel 2002). More recently, papers such as Aghion et al (2006) have found unconditional[9] volatility reduces growth only for less developed countries, for which real exchange rate uncertainty exacerbates the negative effect on investment of domestic credit market constraints. Consistent with this, Schnabl (2007) found a positive effect of reduced unconditional[10] real exchange rate volatility on growth for small emerging open economies of the EMU periphery, but not for non-EMU industrial countries. Bagella et al (2005) found that unconditional real exchange rate volatility harms growth ("costs of volatility") but so does adoption of pegged exchange rates. ("advantages of flexibility"). Serven (2003) using GARCH measures of uncertainty, found a negative and highly significant impact of real exchange rate uncertainty on private investment in a sample of developing countries, after controlling for standard investment determinants.

There has nevertheless also been work finding a negative effect of exchange rate volatility on investment in advanced countries. For example, Darby et al (1999) assessed unconditional volatility of the exchange rate and found a negative effect on investment in US, Germany and France but concluded that it did not matter for Italy and the UK, although these differences were not subject to significance tests.

Byrne and Davis (2005a) used Pooled Mean Group (PMG) panel data studies to look at the factors affecting business investment in the G-7 in order to address the role of risk in investment. Conditional GARCH measures were used to isolate the predictable components of uncertainty to estimate their effects on investment. The authors looked at uncertainty as measured by conditional volatility of monthly CPI, long rates, effective nominal and real exchange rates, industrial production and equity prices; the authors found that only nominal and real exchange rate uncertainty have important negative impacts on investment for the whole sample, and exchange rate uncertainty effects appear to increase over time. There is also evidence that long term interest rate uncertainty matters in Europe, although the evidence

[7] Measured as the standard deviation of the REER over each year, using monthly data.
[8] Measured as the standard deviation of the log first difference of the bilateral nominal rate, monthly over 1995-2000.
[9] Measured as the annual standard deviation of the growth rate of the REER.
[10] Measured as the standard deviation of monthly exchange rate changes and January over December percent exchange rate changes.

is not robust. [11] These findings underline the importance of investigating macroeconomic factors underlying exchange rate volatility in advanced as well as developing countries.

These results have a particular resonance for EMU. Whereas it was widely agreed in advance of EMU that nominal exchange rate volatility would decline due to the fixing of much of the trade weighted basket for EMU countries, this was not the case necessarily for real exchange rate volatility. This is because the monetary adjustment mechanisms of exchange rate and interest rate adjustment are no longer available for EMU countries which are subject to asymmetric shocks from the supply side or demand side. The burden of adjustment is instead on relative wages and prices, and the real economy per se, where the former may impact on real exchange rate volatility. This can be seen as parallel to balance of payments adjustments in the case of fixed exchange rates (Tamborini 2001). Indeed to the extent that the wage/price mechanism (generating potential real exchange rate volatility) is subject to rigidities, there may be over and undershooting of equilibrium levels of output following asymmetric shocks (Deroose et al 2004). There may of course be other causes of differential inflation performance such as relative productivity, profit margins, cyclical and labour supply developments (Arpaia and Pichelmann 2007).

3 Conditional volatility of the real exchange rate

Following Haussmann et al (2006), Serven (2003) and Byrne and Davis (2005a and b) cited above, we estimate GARCH models of real exchange rate volatility to isolate the predictable components of uncertainty which are most likely to have a macroeconomic impact. In the GARCH(p,q) model introduced by Bollerslev (1986) we consider the information set Y_{t-1}, which contains all information on the variable y_t until time t-1. Also we assume the time series y_t can be described as

$$y_t \mid Y_{t-1} = (h_t)^{\frac{1}{2}} \eta_t, \qquad \eta_t \sim NID(0,1) \tag{1}$$

$$h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i y_{t-1}^2 + \sum_{i=1}^{p} \beta_i h_{t-1} \tag{2}$$

where h_t is the conditional variance.[12] Given a coefficient on the lagged squared error α_1 greater than zero, volatility will tend to cluster, with large residuals following other large residuals, but of unpredictable sign, while a random, normally-distributed variation in the conditional distribution (error variance) gives the unconditional distribution (error distribution) fatter tails than the normal distribution.[13]

Most of the GARCH studies in the literature, which are for stock returns, the term structure or exchange rates, have found a significant degree of both short and long run shock persistence with high frequency data, thus accounting for the clustering of volatility characteristic of such markets (Bollerslev et al. 1992). Studies of inflation have found similar results (Engel, 1983).

[11] In complementary work Byrne and Davis (2005b) examined the relationship between aggregate investment and nominal effective exchange rate uncertainty in the G7, using panel estimation and a decomposition of volatility into the short and long run components derived from a Components GARCH model. They found that for a poolable subsample of European countries, it is the transitory and not the permanent component of volatility which adversely affects investment.

[12] To ensure a well-defined process, all the parameters in the infinite order AR representation must be non-negative, where it is assumed that the roots of the polynomial lie outside the unit circle. For a GARCH(1,1), a sufficient lag length in most applications according to Bollerslev et al. (1992), this amounts to ensuring that both α_1 and β_1 are non-negative. It follows also that y_t is covariance stationary if and only if $\alpha_1 + \beta_1 < 1$.

[13] Using the coefficient β_1 on the lagged dependent variable and setting the conditional variance constant, GARCH enables a long run response of the conditional variance to shocks to be calculated. $\alpha_0/[1 - \alpha_1 - \beta_1]$ is the mean level of volatility.

Our monthly data set for real effective exchange rates is from the IMF, and uses the ratio of the domestic consumer price index (CPI) to the trade weighted average of the exchange rate adjusted CPI's in other countries. It covers the period 1980M1-2007M12[14], but estimates of the conditional variance used data only until 2007M10 to ensure that all series had comparable length.

We estimated GARCH(1,1) equations for all countries, with the dependent variable being the monthly first difference of the log of the real effective exchange rate based on the CPI as defined above. The conditional mean equations feature lags of the first difference and also some dummies to remove the most extreme outliers (such as those generated by ERM realignments). As shown in Table 1, our estimates of the conditional variance equation show significant ARCH and GARCH coefficients for most countries, with the exception of Belgium and Austria where there is an insignificant GARCH coefficient (i.e. there are only ARCH effects). All of the estimates are stable, with the combined ARCH and GARCH adding up to less than 1.

Table 1: GARCH estimates for real effective exchange rate volatility 1980M1-2007M10

	Belgium	***Denmark***	***Finland***	***France***	***Germany***	***Greece***	***Italy***
ARCH (α_i)	**0.228**	**0.133**	**0.517**	**0.079**	**0.198**	**0.128**	**0.259**
	(2.1)	**(3.6)**	**(5.3)**	**(2.2)**	**(3.0)**	**(2.4)**	**(5.5)**
GARCH	**0.214**	**0.798**	**0.216**	**0.838**	**0.382**	**0.839**	**0.587**
(β_i)	**(1.1)**	**(13.3)**	**(2.5)**	**(5.8)**	**(2.0)**	**(19.0)**	**(7.1)**
	Ireland	***Neths***	***Austria***	***Portugal***	***Sweden***	***Spain***	***UK***
ARCH (α_i)	**0.11**	**0.174**	**0.133**	**0.115**	**0.057**	**0.097**	**0.191**
	(1.7)	**(3.5)**	**(2.1)**	**(3.4)**	**(1.9)**	**(5.0)**	**(2.8)**
GARCH	**0.655**	**0.587**	**0.552**	**0.862**	**0.837**	**0.897**	**0.644**
(β_i)	**(3.1)**	**(6.4)**	**(1.8)**	**(25.2)**	**(10.4)**	**(49.9)**	**(5.5)**

T values in parentheses

Table 2 reports average conditional real exchange rate volatility in roughly six year periods for the European countries we study. This measure of conditional volatility is the GARCH generated variance of the difference in the (log of) the real effective exchange rate as generated by the above equations. A cross sectional comparison can be made by reference to the memo item, which is an index of average conditional volatility over the whole period, where German average volatility equals 100. Interestingly, it shows that Germany is by no means the most stable in terms of average real exchange rate volatility. Belgium, Denmark, France, the Netherlands, Austria and even Portugal has lower average conditional volatilities. This is likely to reflect the differing patterns of trade, where these countries' trade is focused on Germany and each other, while German trade is relatively more focused on the rest of the world. It is also consistent with the finding of Devereux and Lane (2002) cited above that large countries have more volatile real exchange rates, other things being equal.

Table 2: Conditional volatility of the real effective exchange rate
average over the period

	Belgium	***Denmark***	***Finland***	***France***	***Germany***	***Greece***	***Italy***
1980-1985	4.91E-05	8.31E-05	6.00E-05	9.37E-05	9.65E-05	0.00038	7.44E-05
1986-1992	4.97E-05	6.23E-05	0.000130996	6.56E-05	8.77E-05	0.000182	9.91E-05
1993-1998	5.45E-05	7.38E-05	0.000156994	6.75E-05	8.66E-05	0.000132	0.000202

[14] The data are ..RECZF.. from the IMF database in February 2008. The data are subject to continual but minor revision

1999-2007	4.80E-05	5.50E-05	9.12E-05	6.01E-05	8.24E-05	0.000105	7.53E-05
Memo: Full period Germany =100	57	76	124	80	100	214	124
	Ireland	***Neths***	***Austria***	***Portugal***	***Sweden***	***Spain***	***UK***
1980-1985	0.000139	8.15E-05	3.60E-05	0.00014	0.000147073	0.000133	0.000301
1986-1992	0.000118	5.82E-05	3.36E-05	4.67E-05	0.00013801	0.000106	0.000263
1993-1998	0.000148	6.38E-05	3.74E-05	6.77E-05	0.000207065	0.000145	0.000221
1999-2007	0.000122	6.29E-05	3.29E-05	2.96E-05	0.000176916	2.87E-05	0.000179
Memo: Full period Germany =100*	149	75	40	75	191	109	269

Sources: IMF February 2000 database for RECZF, authors' calculations * Index is based on the full sample period and shows volatility relative to Germany.

Table 3 gives a time series comparison country by country, where average volatility over 1980-5 (when ERM realignments were still common) is set to 100. Comparing the EMU period 1999-2007 with the preceding 1993-1998 (hard ERM post crisis), we see that of the EMU member countries, real exchange rate volatility has fallen markedly (by 20 per cent or more) since the introduction of the common currency in Finland, Italy, Greece, Portugal and Spain. It has also fallen by between 5 and 20 percent in Belgium, France, Germany, Ireland and Austria but is virtually unchanged in the Netherlands, consistent with the hard link to the DM up to EMU.

Amongst the countries that are not members of the Euro Area there was also a decline for Denmark of a similar magnitude to that in the first group, and a comparable fall in Sweden and the UK to the members of the second group. Looking at the earlier periods, we see rather stable volatilities in 1980-92 in Belgium, Germany, Ireland, Austria and the UK, and also since 1986 for the Netherlands. In Sweden, volatility was lower in the pre 1992 period than since then. For Finland and Italy volatility was lower before 1985 than in the hard ERM pre crisis period 1986-98.

Table 3: Conditional volatility of the real effective exchange rate

Index 1980-1985=100

	Belgium	***Denmark***	***Finland***	***France***	***Germany***	***Greece***	***Italy***
1980-1985	100	100	100	100	100	100	100
1986-1992	101	75	218	70	91	48	133
1993-1998	111	89	261	72	90	35	271
1999-2007	98	66	152	64	85	28	101
	Ireland	***Neths***	***Austria***	***Portugal***	***Sweden***	***Spain***	***UK***
1980-1985	100	100	100	100	100	100	100
1986-1992	85	71	93	33	94	79	87
1993-1998	106	78	104	48	141	109	73
1999-2007	88	77	91	21	120	22	59

Sources: NiGEM database, authors' calculations

4 Estimating the causes of exchange rate volatility

We now undertake analysis of the impact of EMU on real conditional exchange rate volatility, estimating quarterly over the period 1980Q2-2007Q2[15]. As noted, over this period, the EU

[15] The time period for the panel is shortened so as not to conflate effects of the banking crisis with the measurement of exchange rate volatility

saw several different exchange rate regimes. First was the ERM with realignments (1980-5), then the hard ERM (1986-92). This was followed by a period of crisis and significant exchange rate movements in the early years in the run up to membership of EMU (1993-98) when countries such as Italy, Spain, Finland and Greece either rejoined, or joined the ERM for the first time. This was a period of increased volatility for Italy, Ireland, Finland, Denmark Portugal, Spain and Sweden as well as Austria, the Netherlands and Belgium. Finally there is EMU itself, and in 2001 Greece joined the Euro Area as well.

Besides allowing for these regimes, as discussed below, we control for autonomous effects on volatility typical of OECD countries. This is to avoid omitted variables bias. We allow for volatility to be driven by levels of inflation (INFL, proxying vulnerability to inflation volatility and terms of trade shocks), the level of short-term real interest rates (R3M, proxying vulnerability to monetary shocks) and the size of the current balance as a percent of GDP (CBR, proxying capital account shocks and openness). The choice of variables follows the literature survey above. Since these countries are comparable in terms of real incomes we do not use a per capita GDP variable, while a trade related openness variable proved not to be significant. Macro data being quarterly, we transform the monthly GARCH conditional volatility series by taking the end-quarter level of conditional volatility, along the lines of Byrne and Davis (2005a) who used a similar transformation.

We began by testing for the order of integration of each series and the results of the unit root tests are summarised in Table 4. The test results suggest that all series are I(0), except the inflation rates in most countries and the current balance in the UK, Sweden and Germany. In practice we treat all the series as stationary in the regression except inflation which enters as a first difference, following these results.

Table 4: Unit root tests over 1980Q1-2007Q3

Philips-Perron test, bandwidth selected by Newey West

	Real conditional exchange rate volatility (REFEX)	Log of 3 month real interest rate (log (1+R3M))	Log of inflation rate (log (1+INFL))	Log of current account balance/GDP (log (1+CBR))
Belgium	-8.3***	-5.8***	-2.3	-7.0***
Denmark	-4.4***	-4.7***	-1.7	-5.1***
Finland	-7.9***	-7.9***	-1.7	-2.8*
France	-4.2***	-3.7***	-2.4	-3.7***
Germany	-8.7***	-8.5***	-2.3	-1.2
Greece	-4.0***	-4.1***	-0.8	-8.2***
Italy	-3.8***	-4.6***	-2.9**	-5.6***
Ireland	-5.7***	-6.4***	-2.6*	-6.7***
Netherlands	-7.1***	-12.6***	-2.9**	-5.6***
Austria	-8.0***	-7.6***	-1.8	-2.6*
Portugal	-3.9***	-10.3***	-1.5	-5.0***
Sweden	-4.3***	-11.9***	-3.2**	-1.6
Spain	-2.8*	-7.2***	-2.7*	-3.3***
UK	-5.3***	-8.4***	-4.8**	-2.3

Critical value at 1%: -3.5, 5%: -2.9, 10%:2.6.

We constructed a panel of 14 countries, 3 of which are outside the current Euro Area. We use the method of seemingly unrelated regressions as our approach, given likely cross effects in the equation errors. Each cross section is estimated by the equation of the following form:

$$\begin{aligned} REFEX_{it}* &= C + a1*d\log(1+INFL_{it}) + a2*\log(1+R3M_{it}) + a3*\log(1+CBR)_{it} \\ &\quad + a4*ERM + a5*ERMH + a6*EMU + a7*EMU_{gr} \end{aligned} \tag{9}$$

where REFEX, INFL, R3M and CBR are as defined in Table 4. The exchange rate regimes are proxied as follows. All are non-stochastic shift dummies. The ERM – soft Exchange Rate Mechanism – variable covers the period until 1986Q4. ERMH covers the hard ERM period pre crisis from 1987Q1 to 1992Q4 The EMU variable begins in 1998Q2 once the exchange rates at which the countries would enter the monetary union were set until the end of the sample. EMU-01 captures the additional impact of EMU in 2001, following the inclusion of Greece and heightened shadowing by Sweden. The post crisis period leading up to EMU 1993Q1-1998Q1 is left as a baseline period to avoid overidentification, and to allow the EMU dummy to show the immediate effect on real conditional volatility.

It has been common in the literature to estimate panels with common coefficients without testing the validity of the imposition of those commonalities. We did undertake such tests and we were unable to justify imposing common coefficients on the variables and dummies according to Wald tests imposed on one variable at a time in order to give the maximum possibility of them being acceptable[16]. Hence we sought a parsimonious form of a fixed effects estimate. Final estimates are presented in Table 5. Insignificant coefficients were removed for all variables[17] with the exception of the EMU dummies themselves.

Our results do not suggest a uniform set of determinants of real effective exchange rate volatility in the EU. We find that a higher current account deficit increases real exchange rate volatility (in Finland, France, Germany, Austria and Spain) although in Belgium the opposite is true. (Note that a larger deficit implies CBR becoming more negative.) Higher real interest rates correspond to higher exchange rate volatility in Belgium, Finland, Italy and the UK, perhaps largely reflecting periods when interest rates have been high to resist pressure for depreciation or realignment. And as would be anticipated, rising inflation is related to higher exchange rate volatility in Belgium, Denmark, Finland, Germany, Ireland, Italy and the UK.

Table 5: Determinants of real effective exchange rate volatility, 1980Q2-2007Q2

country	FIXED EFFECT	DINFL	R3M	CBR	ERM	ERMH	EMU	EMU_01
BG	-0.00128	0.000494	0.00017	0.000117	-5.4E-06	-9.1E-06	-5.1E-06	n.a.
	-3.3	2.7	2.9	2.5	-1.3	-2.4	-1.5	n.a.
DK	7.21E-05	0.000733	n.a.	n.a.	9.38E-06	-8.7E-06	**-1.8E-05**	n.a.
	17.9	3.1	n.a.	n.a.	2.0	-1.6	**-3.4**	n.a.
FN	0.000749	0.001912	0.000393	-0.000514	-0.000163	-0.000156	**-7.0E-05**	**-0.00011**
	0.5	2.3	1.8	-2.1	-7.5	-5.7	**-2.9**	**-3.6**
FR	0.001002	n.a.	n.a.	-0.000201	7.72E-06	-1.31E-05	**-1.9E-05**	n.a.
	1.6	n.a.	n.a.	-1.5	1.7	-2.4	**-4.2**	n.a.
GE	0.001174	0.00044	n.a.	-0.000236	8.9E-06	n.a.	-2.6E-06	n.a.
	5.0	2.2	n.a.	-4.6	2.8	n.a.	-0.7	n.a.
GR	0.0001	n.a.	n.a.	n.a.	0.00031	n.a.	**0.000174**	**-0.000196**
	4.8	n.a.	n.a.	n.a.	9.4	n.a.	**4.0**	**-4.6**
IR	0.000137	0.000479	n.a.	n.a.	n.a.	-2.2E-05	**-1.46E-05**	n.a.
	28.2	1.4	n.a.	n.a.	n.a.	-2.8	**-2.0**	n.a.
IT	-0.00391	0.00362	0.000875	n.a.	-6.4E-05	-8.8E-05	**-5.16E-05**	n.a.
	-4.4	3.9	4.6	n.a.	-4.7	-6.3	**-3.6**	n.a.
NL	0.000065	n.a.	n.a.	n.a.	n.a.	n.a.	-5.1E-06	n.a.
	26.5	n.a.	n.a.	n.a.	n.a.	n.a.	-1.2	n.a.

[16] The Wald test for equality of the coefficients on the change in inflation is failed at 37.4 (p-value 0.0004) as are those for the real interest rate (40.92 (0.0001)), the current balance (42.99 (0.0000)), ERM (273.11 (0.0000)), ERMH (147.12 (0.0000)) and EMU (107.98 (0.0000)).

[17] For instance the UK was not a member of the first ERM but the impacts were significant and negative, whilst it was a member of the second phase of the ERM, but the impacts were small and positive, at least as measured by the GARCH based estimate of the conditional volatility of the real effective exchange rate

OE	0.0003	n.a.	n.a.	-0.0000573	n.a.	-2.33E-06	**-3.77E-06**	n.a.
	3.1	n.a.	n.a.	-2.7	n.a.	-1.9	**-2.7**	n.a.
PT	0.0000711	n.a.	n.a.	n.a.	4.97E-05	-2.12E-05	**-4.14E-05**	n.a.
	9.7	n.a.	n.a.	n.a.	5.1	-2.1	**-4.5**	n.a.
SD	0.000227	n.a.	n.a.	n.a.	-8.25E-05	-8.31E-05	**-5.08E-05**	**-6.07E-05**
	29.7	n.a.	n.a.	n.a.	-8.3	-9.2	**-5.3**	**-4.6**
SP	0.001582	n.a.	n.a.	-0.00031	-4.42E-05	-5.6E-05	**-0.00014**	n.a.
	1.7	n.a.	n.a.	-1.5	-2.6	-3.2	**-7.8**	n.a.
UK	-0.00548	0.002744	0.00123	n.a.	7.0E-05	n.a.	-2.5E-05	n.a.
	-3.1	2.6	3.2	n.a.	3.0	n.a.	-1.1	n.a.

Notes: Countries in order in which they appear in the table: Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Austria, Sweden, Spain, UK and the US. Numbers in parentheses are the associated t-statistics. Omitted coefficients are denoted by n.a.

Our main interest is in the dummies, which as noted above measure significant differences in volatility between the period concerned and the base period 1993-8, taking into account the above-mentioned macroeconomic determinants of volatility. The first stage of the ERM, 1980-6, featured lower real exchange rate volatility than in 1993-8 amongst all its members except Denmark, Germany and France. Greece, Portugal and the UK had significantly higher volatility over this period but were not ERM members. The hard ERM period 1987-92 had lower real exchange rate volatility than in 1993-8 for all countries except Germany, Greece, the Netherlands and the UK where no significant effect was detectable.

Virtually all countries benefited from the introduction of EMU, with the main exceptions among EMU members being the hard currencies Belgium, Germany and the Netherlands which trade largely with each other or with the non-EMU world. Their real exchange rate volatility was unchanged, when allowing for other influences. EMU was also found to reduce volatility for non-EMU members Sweden and Denmark, of which the latter had de-facto fixed their exchange rate vis-à-vis the euro from the outset. Finland and Sweden enjoyed a further step-down in volatility in 2001 (as shown by the EMU_01 variable), as the Swedish kronor began to shadow the euro in 2001[18]. The EMU_01 variable also shows the impact of the joining of EMU by Greece, which reversed an upturn in volatility for the Drachma over 1998-2000. By contrast, our results suggest that those, such as the UK, which pursue independent monetary policy but have close trade links with the Euro Area are likely to have experienced no change in the volatility of the real effective exchange rate as a result of EMU.

The impacts by country suggest that those with the highest exchange rate volatility, such as Spain, Finland and Italy gained the most from joining EMU, when taking into account underlying determinants of volatility. The impacts of EMU on the volatility of the real effective exchange rates for Germany, Belgium and the Netherlands are insignificant, while it is also small for Austria. Other than for Germany, this is in line with their strong trade orientation to other members of the monetary union and existing monetary discipline due to the hard link to the DM. Meanwhile, Germany may not have benefited due to its large export exposure to the rest of the world, leaving a predominant effect of the external volatility of the euro.

[18] In the seven years to 2007q4 the volatility of the bilateral kroner-euro exchange rate was 0.127. less than a third of the volatility of the actual and synthetic euro rate in the seven years prior to 2001

Figure 1 The Impact of EMU on Real Exchange Rate Volatility
(conditional on other macro variables)
Significant coefficients are shaded

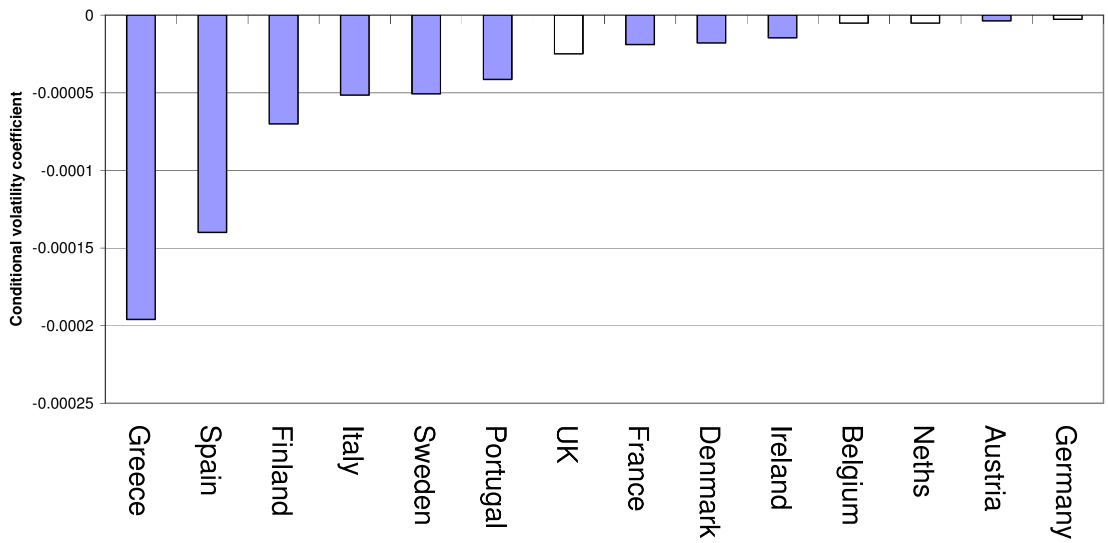

Figure 1 plots the relative size of the coefficients on EMU on conditional volatility after taking into account significant macroeconomic factors such as inflation, the real exchange rate and the real interest rate. The impacts on the outsiders, Denmark and Sweden are generally significantly larger than in the core countries, Germany, Austria, Belgium and the Netherlands. These core countries along with France, Ireland, and Denmark have noticeably smaller effects than in the initially volatile EMU members that joined the European Union at a later date than others, Greece, Spain, Finland. Italy and Portugal, also a late joiner, display effects similar to those of Sweden and larger than the core long term members of the European Union. The impact of EMU on the volatility of the real effective exchange rate for the UK is statistically insignificant, as is that for Germany, Belgium and the Netherlands.

Conclusions

We have shown that EMU has had a beneficial effect on conditional real exchange rate volatility for most EU countries, with the chief exceptions being Germany, Belgium and the Netherlands, and outside EMU, the UK. These effects are still detectable when background factors influencing exchange rate volatility such as inflation, interest rates and current account positions are allowed for. Given the recent work highlighting the benefits of lower real exchange rate volatility to growth, the EU in general and EMU countries that were previously volatile in particular, should benefit from EMU in terms of fixed investment and economic growth. On the other hand, a note of caution that requires further investigation is whether in some countries low real rate volatility might be indicative of sluggish price and wage adjustment dynamics, that entails macroeconomic disequilibria.

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