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The Exchange Rate Policy of the Euro: a Matter of Size?

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RESUME

L'intégration monétaire en Europe étant un événement sans précédent historique, nous ne savons que peu de choses sur ses effets. Cependant, un effet est connu et certain: la zone créée par l'Union Economique et Monétaire (UEM) sera plus grande (beaucoup plus grande dans le cas d'une UEM avec 15 pays) que les pays européens pris séparément. Dans ce document, nous partons de cet effet de taille de l'UEM et l'exploitons pour analyser d'un point de vue théorique et empirique la question de la politique de taux de change en UEM. Nous montrons que la taille des pays est un déterminant important de la politique monétaire en économie ouverte et de l'instabilité des taux de change, car elle modifie l'incitation à utiliser la politique monétaire pour influencer le taux de change.

Une manière d'analyser cet effet de taille en termes économiques est d'interpréter la création de l'euro comme une modification de la taille relative des joueurs dans les relations monétaires internationales. La théorie des jeux nous apprend en effet que la taille des joueurs est importante pour déterminer les stratégies et donc la situation d'équilibre. Nous construisons un modèle simple qui donne un rôle central à la taille des pays comme déterminant des politiques monétaires et de la variabilité du taux de change. Nous testons ensuite le modèle de manière empirique et exploitons ces résultats pour suggérer quelques implications pour le taux de change de l'euro.

Dans la section théorique, un modèle à deux pays est développé dans lequel les changements de taux de change non anticipés peuvent aider les pays à stabiliser leur économie lors de chocs. Pendant une récession par exemple, un pays peut atténuer la perte d'emploi et de production en diminuant son taux de salaire réel en dessous du niveau des autres pays, ce qui revient à une dépréciation compétitive. L'incitation d'un grand pays à utiliser stratégiquement la politique monétaire pour stabiliser son économie est moindre que celle d'un petit pays, car sa production dépend moins du taux de change que celle d'un petit pays. Un grand pays devrait donc avoir un taux de change plus stable qu'un petit pays. Cependant, lorsque le pays est « très petit », la variabilité du taux de change devient une source plus importante d'instabilité de la production que les chocs d'origine nationale. Cela implique que les « très petits » pays utiliseront leur politique monétaire pour stabiliser leur taux de change. Nous montrons donc que la relation entre la variabilité du taux de change et la taille des pays devrait avoir une forme en cloche. Le modèle prédit aussi que la variabilité du taux de change devrait être une fonction croissante de la variabilité des chocs dans chacun des pays (car le taux de change réagit à ces chocs) et une fonction décroissante de la corrélation des chocs (car une forte corrélation des chocs induit des politiques monétaires similaires et donc un taux de change stable).

Le projet d'UEM entraînant la création d'une très grande zone ayant une devise commune, la relation en cloche suggère que le taux de change de l'euro devrait être plus stable que ceux des devises européennes actuelles. D'un point de vue théorique, cependant, d'autre effets peuvent jouer en sens inverse. Par exemple, d'autres auteurs ont montré que l'UEM pouvait aboutir à une augmentation de l'instabilité du taux de change car devenant une économie plus fermée, elle serait moins touchée par des déséquilibres commerciaux et par les conséquences inflationnistes des changements de taux de change. Ces études appartiennent à la tradition des modèles qui prédisent que la fixation du taux de change (dans le cas de l'UEM, son élimination) transfère la volatilité à d'autres variables

macroéconomiques (dans le cas de l'UEM aux taux d'intérêt et aux taux de change avec d'autres devises).

Puisque la théorie peut prédire un effet positif ou négatif de l'UEM sur l'instabilité du taux de change, l'étape suivante est d'analyser la question d'un point de vue empirique.

Nous testons les implications du modèle théorique sur un échantillon de 210 taux de change bilatéraux des pays de l'OCDE sur la période 1980-1995. Nous trouvons que les prédictions du modèle sont validées. En particulier, la relation entre la volatilité du taux de change et taille du pays semble avoir bien une forme en cloche même après avoir contrôlé l'effet d'autres déterminants possibles de la variabilité du taux de change tels que le SME, l'utilisation de la devise comme devise de réserve, la corrélation des chocs, le commerce bilatéral et la volatilité des chocs. Cette relation en cloche est valide pour les taux de changes européens vis-à-vis du dollar. Elle est aussi assez bien vérifiée lorsqu'on exclut les taux de changes que nous considérons comme des observations non indépendantes.

Nous trouvons aussi que les devises du SME de la bande étroite ont eu des taux de change plus stables vis à vis des devises non SME que les devises qui n'étaient pas dans le SME. Cela est le cas même lorsqu'on contrôle l'effet stabilisateur du SME sur les devises de la bande large du SME. C'est un résultat important puisque le SME est l'expérience la plus proche de l'UEM. Il suggère qu'un taux de change quasi-fixe non seulement stabilise les taux de change à l'intérieur de la zone mais aussi les taux de change de la zone vis à vis des devises hors de la zone.

Finalement, nous utilisons les résultats empiriques pour faire une estimation grossière de la variabilité dollar/euro comparée à la variabilité passée du taux de change DM/dollar. Nous trouvons, ce qui est cohérent avec le modèle, une diminution de la volatilité et celle-ci est d'autant plus importante que la zone de l'UEM est plus large. La diminution est quantitativement importante dans le cas d'une UEM large non restreinte aux membres du noyau dur.

Ces résultats peuvent être interprétés comme une illustration de l'impact de l'UEM sur l'incitation à utiliser la politique monétaire pour influencer le taux de change afin de stabiliser l'économie. Ils peuvent donc éclairer le débat sur les pressions politiques auxquelles la Banque Centrale Européenne (BCE) indépendante devra résister. Certains économistes et décideurs politiques craignent que si la responsabilité de la politique de taux de change appartient aux gouvernements plutôt qu'à la BCE, des conflits sur la politique de taux de change et donc la politique monétaire apparaissent entre la BCE et les gouvernements. Nos résultats suggèrent que le problème de conflits éventuels entre la BCE et les gouvernements européens sur la gestion de la politique de taux de change vis à vis du dollar est peut-être exagéré.

SUMMARY

There are many things we do not know about European monetary integration as there is no historical precedent to it. However, we know for sure that the size of the zone created by the EMU will be bigger (far bigger in the case of EMU15) than European countries taken separately. In this paper, we start from this size effect of EMU and exploit it to analyse from a theoretical and empirical point of view the question of exchange rate policy with the EMU. We argue that country size matters as a determinant of monetary policy in an open economy policy and volatility because it changes the incentive to use monetary policy to influence the exchange rate.

One way to analyze this size effect in economic terms is to interpret the creation of the Euro as implying a change in the relative size of players in international monetary relations. From game theory, we know indeed that the size of players matters in determining equilibrium strategies and economic outcomes. We construct a simple model which gives a central role to country size as a determinant of monetary policies and exchange rate variability. We then test its empirical implications and exploit the results to suggest some consequences for the euro exchange rate.

In the theoretical section, a two country model is developed in which unanticipated changes in the exchange rate can help countries stabilize their economy when shocks occur. This is because, during a recession for example, a country can gain employment and output if it succeeds in lowering its real wage below the level of other countries which amounts to a real depreciation. A large country will have less incentive to use strategically its monetary policy to stabilize its economy than a small country because its output depends less on the exchange rate than a small country. Hence, large countries should have more stable exchange rates than small ones. However, when the country becomes « very small », exchange rate variability becomes more important as a source of output variability than domestic shocks. This implies that « very small » countries will use their monetary policy to stabilize their exchange rate. Hence, we find that exchange rate variability should be a hump-shaped function of country size. The model also predicts that exchange rate variability should be an increasing function of the variability of shocks in both countries (because the exchange rate reacts to those shocks) and a decreasing function of the correlation of shocks (because a high correlation of shocks induces similar monetary policies and a stable exchange rate).

As EMU entails the creation of very large common currency zone, the hump shape relation suggests that the euro exchange rate should be more stable than the European currencies. From a theoretical point of view however, other channels may lead to higher exchange rate volatility. Other authors argue on theoretical grounds that EMU should lead to higher exchange rate instability because being a more closed economy, it will be less concerned with trade imbalances and the inflation consequences of exchange rate changes. These papers belong to the tradition of models which predict that the fixing of the exchange rate (in the case of EMU its elimination) transfers the volatility to other macroeconomic variables (in the case of EMU to the interest rate and exchange rate with other currencies).

As the theory can predict a positive or a negative effect of EMU on exchange rate instability, the next natural step is to attempt to analyze the question at the empirical level.

We test the implications of the theoretical model on a cross section of 210 bilateral exchange rates of the OECD countries for the period 1980-1995. We find that the model works well and that indeed the volatility of the exchange rate seems to have a hump shaped relation with country size even after controlling for several other determinants of exchange rate volatility such as the EMS, the use of the currency as a reserve currency, correlation of shocks, bilateral trade and volatility of shocks. The relation also works reasonably well on subsamples of bilateral exchange rates which exclude certain exchange rates which we believe not to be independent.

We also find that the narrow band EMS currencies have had more stable exchange rates with respect to currencies not in the EMS than non EMS currencies. This is so even after controlling for currencies in the wide band EMS. This is an important result as EMS is the closest experiment of EMU that we have. It suggests that a quasi-fixed exchange rate zone not only stabilizes exchange rates in the zone but also exchange rates of the zone with outside currencies.

Finally, we use the empirical model to make a "back of the envelope" prediction exercise of what the dollar/euro variability might be compared to the past variability of the dollar/DM exchange rate. We find that it should decrease and consistent with the results of the model this decrease should be more important the larger the size of the EMU. The decrease becomes quantitatively important in the case of a large EMU not restricted to the core countries.

Our results can be interpreted as describing how the incentives to use monetary policy to influence the exchange rate in order to stabilise output may change with EMU. They can therefore shed some light on the likely political pressures that the independent ECB will have to resist. Some economists and policy makers fear that if the responsibility of the exchange rate policy is in the hands of the governments rather than the ECB, this may lead to conflicts on exchange rate policy and therefore monetary policy. Our results suggest that the problem of possible conflicts between the ECB and the European governments on the management of the exchange rate policy with respect to the dollar may be exaggerated.

THE EXCHANGE RATE POLICY OF THE EURO: A MATTER OF SIZE?[1]

Philippe Martin[2]

I. INTRODUCTION

There are many things we do not know about European monetary integration as there is no historical precedent to it. However, we know for sure that the size of the zone created by EMU will be bigger (far bigger in the case of EMU15) than European countries taken separately. In this paper, we start from this size effect of EMU and exploit it to analyse the question of exchange rate policy with EMU. We argue that country size matters as a determinant of exchange rate policy and volatility because it changes the incentive to use monetary policy to influence the exchange rate.

One way to analyze this argument in economic terms is to look at the creation of the Euro as implying a change in the relative size of players in international monetary relations. From game theory, we know indeed that the size of players matters in determining the equilibrium strategies and economic outcomes. In this paper, we construct a simple model which gives a central role to country size as a determinant of monetary policies and of exchange rate variability. We then test its implications and exploit the results to suggest some consequences for the euro exchange rate.

In the theoretical section, a two country model is developed in which unanticipated changes in the exchange rate can help countries stabilize their economy when shocks occur. This is because, during a recession for example, a country can gain employment and output if it succeeds in lowering its real wage below the level of other countries which amounts to a real depreciation. A large country will have less incentive to use strategically its monetary policy to stabilize its economy than a small country because its output depends less on the exchange rate than a small country. Hence, large countries should have more stable exchange rates than small ones. However, when the country becomes « very small », exchange rate variability becomes more important as a source of output variability than domestic shocks. This implies that « very small » countries will use their monetary policy to stabilize their exchange rate. Hence, we find that exchange rate variability should be a hump-shaped function of country size. The model also predicts that exchange rate variability should be an increasing function of the variability of shocks in both countries and a decreasing function of the correlation of shocks.

As EMU entails the creation of very large common currency zone, the hump shape relation suggests that the euro exchange rate should be more stable than the European currencies. From a theoretical point of view however, other channels may lead to higher exchange rate volatility. For example, Cohen (1997) and Benassy-Quéré et al. (1997) argue on theoretical grounds that EMU should lead to higher exchange rate instability because

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being a more closed economy, it will be less concerned with trade imbalances and the inflation consequences of exchange rate changes. In the same vein, it is often argued that the decrease in exchange rate volatility between two currencies in a fixed exchange rate (its elimination in a monetary union) is merely transferred to other macreconomic variables, one of them being possibly the exchange rates with currencies not in the agreement. However, from an empirical point of view Flood and Rose (1995) have shown that when nominal exchange rates are stabilized, there do not appear to be systematic effects on other macroeconomic variables. Their purpose is very different from ours though and they do not look at the effect of the stability of exchange rates of a zone on the variability of the exchange rates of this zone with the other countries.

As the theory can predict a positive or a negative effect of EMU on exchange rate instability, the next natural step is to attempt to analyze the question at the empirical level. This is what we do in the second section of the paper.

Bayoumi and Eichengreen (1996) have argued that the implications from the optimal currency area literature can be tested by looking at the determinants of exchange rate variability. In the same spirit, we test the implications of the theoretical model on a cross section of 210 bilateral exchange rates of the OECD countries for the period 1980-1995. We find that the model works well and that indeed the volatility of the exchange rate has a hump shaped relation with country size even after controlling for several other determinants of exchange rate volatility. The relation also works reasonably well on subsamples of bilateral exchange rates which exclude certain exchange rates which we believe not to be independent. We also find that the EMS currencies have had more stable exchange rates with respect to currencies not in the EMS than non EMS currencies. This is also consistent with the model. Finally, we use the empirical model to make a “back of the envelope” prediction exercise of what the dollar/euro variability would be compared to the past variability of the dollar/DM exchange rate. We find that, consistent with the results of the model the variability should decrease, the more so the larger EMU.

II. EMU, SIZE AND EXCHANGE RATES

II. 1. A simple two-country model

In the model, two countries 1 and 2 (of normalized size 1 and α respectively) produce a single identical good for which P.P.P. applies. We assume that country 1 is small compared to country 2 so that $\alpha > 1$.

We assume that central bankers in charge of monetary policy in both countries do not cooperate, and that no trigger strategies are possible so that reputation building is ruled out as a commitment device for central banks.[3]

Policy makers in the two countries have the same expected loss function which is similar to the one introduced by Barro and Gordon (1983):

[3] See Canzoneri and Henderson (1991) for trigger mechanisms and reputation in repeated games and why such strategies do not always lead to efficient outcomes.

$$L_i = \tfrac{1}{2}\pi_i^2 + \tfrac{1}{2}\beta y_i^2 \quad , \; i = 1, 2 \qquad \textbf{(1)}$$

where L_i is the expected loss function of country i, a function of π_i the inflation rate, and of the deviation of the log of per capita domestic output y_i, from the log of the socially optimal level of per capita output which we normalize to zero. β is the weight placed on the goal of reaching the optimally social level of output relative to inflation. Time subscripts have been omitted as the game is identical in each period.

The aggregate supply functions (in per capita terms) in the three countries are given by:

$$\begin{aligned} y_1 &= \alpha(p_1 - w_1) - \alpha(p_2 - w_2) + \varepsilon_1 \\ y_2 &= (p_2 - w_2) - (p_1 - w_1) + \varepsilon_2 \end{aligned} \qquad \textbf{(2)}$$

where w is the wage rate and p is the price level. ε_1 and ε_2 are country specific random productivity shocks distributed normally with zero mean, variances σ_1^2 and σ_2^2 and covariance σ_{12}.

The first part of equation (2), the domestic real wage, is the usual mechanism in Barro-Gordon type models which give unexpected monetary policy changes a real effect. The second part of equation (2), similar to Martin (1995a), can be explained the following way. Imagine a multinational firm that has production units in both countries and has to decide where to increase or decrease its labor demand and its production. What the second part of equation (2) says is that, given that P.P.P holds, so that the good can be sold at the same price everywhere, the firm will choose to increase labor demand and production relatively more in the country that has a lower real wage. This will create an incentive for each government to inflate away the domestic real wage to import jobs and production from the foreign country at a given foreign real wage during recessions (ε negative).

The coefficients in equation (2) reflect the size of countries. Countries are defined as a collection of regions for which monetary policy is decided by a single authority and for which there is a single shock (see appendix for an explicit derivation of the size coefficients). If countries were of identical size (α = 1), the supply functions would be identical. For a small country, the potential transfer of employment and output if it has a lower real wage, is larger than for a large country when measured in per capita terms. This is because, for a small country any differential in real wage will involve, <u>ex ante</u>, an employment and output transfer larger (the rest of the world) than for a large country.

Wage setters want to minimize the variability of the real wage so that their utility can be represented by:

$$U_i = -E(p_i - w_i)^2 \quad , \; i = 1,2 \qquad \textbf{(3)}$$

As usual in this type of set up, the shocks are not observed by wage setters before setting their wage but the monetary authorities observe all shocks before they set monetary policy. The expected utility-maximizing strategy for wage setters is thus to set nominal wages equal to expected price: $w_i = p_i^e$. Output can then be rewritten in terms of expected and actual inflation rates:

$$\begin{aligned} y_1 &= \alpha(\pi_1 - \pi_1^e) - \alpha(\pi_2 - \pi_2^e) + \varepsilon_1 \\ y_2 &= (\pi_2 - \pi_2^e) - (\pi_1 - \pi_1^e) + \varepsilon_2 \end{aligned} \qquad \textbf{(4)}$$

As PPP holds so that the change in the exchange rate is equal to the difference in inflation rates (i.e. $E_{12} = \pi_1 - \pi_2$), this equation states that output is affected positively by a depreciation which is unexpected by wage setters:

$$\begin{aligned} y_1 &= \alpha(E_{12} - E_{12}^e) + \varepsilon_1 \\ y_2 &= -(E_{12} - E_{12}^e) + \varepsilon_2 \end{aligned} \qquad \textbf{(5)}$$

The incentive to play on the relative costs of production resembles incentives for competitive depreciations which have been modeled by Canzoneri and Gray (1988) or Tabellini and Persson (1996). Tabellini and Persson for example put directly the real exchange rate in the loss function in such a way that a systematic incentive for competitive depreciations emerges. What is key to our results is not the exact channel that induces the policy maker to play on the exchange rate. Rather it is that the exchange rate is more important for small countries both as a device to stabilize the economy but also as a source, in itself, of variance of output. The first supply function of equation (5) shows this double role of exchange rate both as a potential stabilizer (when the change in the exchange rate has the opposite sign to the domestic shock) and as a potential destabilizer of output.

Note that because we want to focus on the interaction between the two countries and the exchange rate instrument, we have constructed the supply function such that at the world level the Phillips curve is vertical: $y_1 + \alpha\, y_2 = \varepsilon_1 + \alpha\, \varepsilon_2$.

II. 2. Optimal monetary policies and the volatility of the exchange rate

To simplify further, we assume that the inflation rate is perfectly controlled by monetary authorities through monetary expansions and contractions so that $\pi_i = m_i$

where m_i is the rate of increase in the money supply of country I.

The problem for country i is to minimize its loss function taking as given the monetary strategies of the other country. The resulting optimal monetary policies in this Nash equilibrium are:

$$m_1 = -\frac{\alpha\beta(1+\beta)}{1+\beta+\alpha^2\beta}\varepsilon_1 - \frac{\alpha^2\beta^2}{1+\beta+\alpha^2\beta}\varepsilon_2$$
$$m_2 = -\frac{\beta\left(1+\alpha^2\beta\right)}{1+\beta+\alpha^2\beta}\varepsilon_2 - \frac{\alpha\beta^2}{1+\beta+\alpha^2\beta}\varepsilon_1 \qquad \textbf{(6)}$$

The exchange rate change is then:

$$E_{12} = m_1 - m_2 = \frac{\beta\varepsilon_2}{1+\beta+\alpha^2\beta} - \frac{\alpha\beta\varepsilon_1}{1+\beta+\alpha^2\beta} \qquad \textbf{(7)}$$

In the special case where shocks are identical the exchange rate change is:

$$E_{12} = \frac{\beta(1-\alpha)\varepsilon}{1+\beta+\alpha^2\beta} \qquad \textbf{(8)}$$

Only if the two countries were identical in size, would the exchange rate be stable. Otherwise the small country will be able to use its small size to engineer a depreciation during recessions and an appreciation during booms. In the monetary game between the two countries, the small country has more incentive to use the exchange rate as a policy instrument to stabilize output. In equilibrium therefore in the Nash equilibrium this will imply that in face of a symetric shock, the small country will react more to it than the large country. This is linked with the free-rider problem identified in Martin (1995a)[4].

We can now analyze the determinants of the variance of the exchange rate:

$$\mathrm{var}(E_{12}) = \frac{b^2}{[1+b+a^2b]^2}\left[a^2 s_1^2 + s_2^2 - 2as_{12}\right] \qquad \textbf{(9)}$$

The exchange rate volatility depends positively on the variance of output shocks in both countries, and negatively on the covariance of their output shocks. Note that the relation between the variance and the covariance of shocks on the one hand and the volatility of the exchange rate on the other hand is the same as the one predicted by optimum currency area theory as interpreted by Bayoumi and Eichengreen (1996). The determinants of exchange rate variability would also be the same in a Mundell-Fleming type of model. Here the intuition of the mechanism is the following. When the variance of output shocks is high, countries, everything else given, have more incentive to use the exchange rate strategically to stabilize output. Hence, for a given covariance of shocks and size differential, monetary policies will be more volatile so that the exchange rate itself will be more volatile. When the covariance of shocks is high, everything else given, monetary

4 Here, we focus on the effect of country size on the variability of the exchange rate. If an inflation bias was introduced through which policy makers attempt to systematically use the exchange rate to attain a socially optimal level of output higher than the normal level, then small countries would be more inflationary than large countries. See Martin (1994) for a theoretical and empirical analysis of the relation between country size and average inflation.

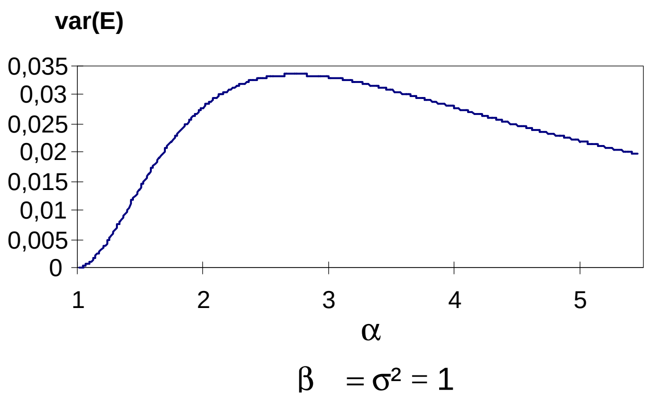
policies in both countries will be more alike so that the exchange rate will be less volatile.

To analyze the impact of country size on the variance of exchange rates we focus on symmetric shocks. In this case, the variance of exchange becomes:

$$\operatorname{var}(E_{12}) = \frac{\beta^2(\alpha-1)^2\sigma^2}{[1+\beta+\alpha^2\beta]^2} \qquad \textbf{(10)}$$

At low values of α, this variance is increasing in α. At high values of α, it is decreasing in α. We can interpret α as either the size differential between the two countries or as the size of the rest of the world if we think of country 2 as the rest of the world. In the first interpretation, this says that the variance of the exchange rate is increasing in the differential in size of the two countries at low levels of this differential and then decreasing in the differential in size of the two countries at high levels of this differential. In the second interpretation, equation (10) says the exchange rate variability has a hump shaped relation with the size of both countries (the larger and the smaller one separately) involved in the exchange rate. Of course the two interpretations are consistent with each other but they generate somewhat different empirical implications as we will see in the empirical section. The graph below illustrates the relation between country size (or size differential) and the exchange rate variability as predicted by our model.

Graph 1:



The intuition of this result is the following. Remember that the exchange rate volatility enters the expected loss function because it affects the volatility of output so that for country 1 in equilibrium:

$$EL_1 = \frac{1}{2}E(\pi_1^2) + \frac{1}{2}\beta E[\alpha E_{12} + \varepsilon_1]^2 \qquad y_1 = \alpha E_{12} + \varepsilon_1 \qquad \textbf{(11)}$$

as $E_{12}^e = 0$. For a given variance of domestic shocks σ^2_1, the equation above shows that monetary policy can, by manipulating the exchange rate, help to stabilize the economy. The exchange rate instrument is, ex ante, more powerful the larger α, that is the larger the size differential between the two countries. In graph 1, this is illustrated by the left part of the hump when exchange rate variability increases with the size differential. However, when α becomes very large, i.e. the size differential becomes very large, equation (11) shows that the main source of output instability in the smaller country is exchange rate instability (due to changes in monetary policy in the larger country) rather than domestic shocks. In this case, the role of monetary policy in the smaller country is to stabilize the exchange rate, the more so the larger the size differential. This is the second part of the hump in graph 1. In the second interpretation, the intuition is similar: “very small” countries want to use monetary policy to stabilize exchange rate so that exchange rate variability increases with size (right side of the hump in graph 1) until the country becomes too large for the exchange rate to be a useful stabilizer (left side of the hump in graph 1).

II. 3. Implications for the exchange rate policy of the EMU: Composition and Size

A priori, the implication of our analysis for the dollar/euro exchange rate is ambiguous because we do not know on which side of the hump EMU will put the dollar/euro exchange rate. However, if we consider that EMU (whatever its composition) will be much larger than any of the European countries taken separately, we should expect the volatility of the Euro with respect to the dollar to decrease compared to the past volatilities of European currencies with respect to the dollar. Moreover, the size differential should decrease drastically and will be quite small or in even reversed in the case of full EMU, so that on this interpretation of the theoretical model we should also expect to see the exchange rate volatility to decrease and to depend on its composition and size.

We can also ask the question how the composition and size of EMU may affect the need for cooperation between Europe and the US on exchange rates. For this, we need to compute the expected equilibrium welfare loss levels. This gives:

$$EL_1 = \frac{1}{2}\frac{\beta(1+\alpha^2\beta)}{[1+\beta+\alpha^2\beta]^2}\left[(1+\beta)^2\sigma_1^2 + \alpha^2\beta^2\sigma_2^2 + 2\alpha\beta(1+\beta)\sigma_{12}\right]$$
$$EL_3 = \frac{1}{2}\frac{\beta(1+\beta)}{[1+\beta+\alpha^2\beta]^2}\left[\alpha^2\beta^2\sigma_1^2 + (1+\alpha^2\beta)^2\sigma_2^2 + 2\alpha\beta(1+\alpha^2\beta)\sigma_{12}\right] \qquad \textbf{(12)}$$

The expected loss is increasing in the variance and the covariance of shocks σ_{12} as the inefficiency of non cooperation increases itself with the variance and the covariance of shocks. The attempt to attract employment and output through changes in the exchange rates is most inefficient for symmetric shocks. For a symmetric recession in the two countries for example and assuming they are of identical size ($\alpha = 1$), the exchange rate is not changed in equilibrium so that no output is transferred but the inflation rate is too high. This means that even though exchange rate variability is lower with higher covariance, the need for cooperation is more important the more the covariance of shocks. this is important in the case of Europe and the US because the composition of EMU influences the covariance of the EMU block with the US. In particular, the question of participation of the UK which has the highest covariance of growth rates with the US is important for the question of cooperation on exchange rate policy with the dollar. This also suggests that exchange rate variability may not be a good indicator of the need for cooperation on exchange rates.

The second question is the one of the size of EMU and its impact on the need for exchange rate cooperation between the US and the EMU[5]. For symmetric shocks it is easy to check that the expected loss level is again a hump shaped function of α. For a given variance of shocks, when country 1 is very small (α is very large), then its optimal policy ex ante is to stabilize the exchange rate and not to strategically use its monetary policy. This implies that the scope for inefficiency will be limited. At the other limit, a large country will not use the exchange rate as a tool to stabilize output. Only when country 1 is relatively large compared to the country 2 or to the rest of the world, will the inefficiency of non cooperation be important. In this case, country 1 can not credibly precommit to a stable monetary policy or to a stable exchange rate and both its monetary policy and exchange rate become unstable which proves inefficient ex post for both countries. This suggests that the need for cooperation between EMU and the US may depend on the size of EMU. On which side of the hump will EMU be relative to the individual European countries? The empirical section suggests that the volatility should decrease with EMU due to the change of size so that the results also suggest that less cooperation should be necessary and the less so the larger EMU.

Hence, on the one hand the model suggests that an EMU with high covariance of shocks with the US requires more cooperation on exchange rates. On the other hand, the larger the size of EMU the less cooperation is needed.

III. EXCHANGE RATE VARIANCE AND SIZE: EMPIRICAL RESULTS

In this section, results on some determinants of exchange rate variability and tests of the theoretical predictions of the previous sections are reported. As one of the objectives is to understand the incentives and forces that will shape the exchange rate policy of the euro, the focus is on the industrialized countries. The variability of the nominal bilateral exchange rate is defined as the standard deviation of the logarithm of the annual change in the exchange rate (measured in January of each year). There are 21 countries and 210 bilateral exchange rates. As Bayoumi and Eichengreen (1996) note, even though changes in bilateral rates are not independent of each other, the standard deviations of these rates are independent because the covariance across pairs of currencies can differ. However, we take into account the possibility that some variances are in fact not independent in the last part of the section. We measure the variability of nominal exchange rates for the period between 1980 to 1995. The measures of variability are given by table 1.

Our theoretical model predicts that exchange rate volatility should increase with the variability of output shocks of the two countries and decrease with the correlation of these shocks. The variability of exchange rates should increase with the differential of size between the two countries at low levels of this differential (or the size of both countries in our second interpretation) and then decrease at high levels of this differential.

[5] A similar question is analysed in a more complex model in Ghironi and Giavazzi (1997).

For the variability of the shocks, we use the sum of the standard deviations of the annual growth rates of GDP of the two countries on the period the variable is called (« sum of SD »). As for the correlation of the shocks we use two different measures: the rate of correlation of the annual growth rates of GDP of the two countries (given in table 3) and the sum of the bilateral trade shares in percentage of each country's GDP for the period 1980-1995 (given in table 2). None of these measures are satisfactory as they do not truly measure exogenous shocks. We use the intensity of bilateral trade as an alternative measure of correlation because it is well known that trade has an important role in the transmission of shocks. Bayoumi and Eichengreen (1996) also have a similar trade intensity measure but give a somewhat different interpretation. They interpret trade intensity as a measure of the opportunity cost of exchange rate variability for both countries.

For the size of both countries, we use the average value of GDP in dollars on the period. We distinguish for each exchange rate between the size of the smallest country of the two countries involved and of the largest of the two. For the differential, we take the absolute value of the difference between the two. Finally, to test whether the relation between the variability of exchange rates and the size differential has the hump shape predicted by the model, we also add the square of the size differential. In the second interpretation we put the size of each country separately (the largest and the smallest separately) as well as the size of each country squared.

The theory predicts the following relation between exchange rate variability and its different determinants:

$$\text{var(exchange rate)} = a_1(\text{sum of SD}) - a_2(\text{trade}) - a_3(\text{correlation}) + a_4(\text{size differential}) - a_5(\text{size differential})^2$$

$$\text{var(exchange rate)} = a_1(\text{sum of SD}) - a_2(\text{trade}) - a_3(\text{correlation}) + a_4(\text{size small}) - a_5(\text{size small})^2 + a_6(\text{size large}) - a_7(\text{size large})^2$$

The results for the whole sample are in tables 4 and 5. Table 4 gives the specification in terms of size differential and table 5 in terms of country size. The equations above are tested in specification {2}. All the coefficients have the right sign[6]. Moreover, the variables that are of most interest for us, those on size, are significant at the 1% or 5% level in both specifications[7]. Note that the correlation coefficient in table 5 is significant only at the 10% level in regressions {1} to {5} may be because of the high correlation with the trade variable. The trade variable has a strong negative impact on exchange rate volatility. The volatility of output has, as expected from the model, a positive impact on the variance of the exchange rate but is not significant in 2 of the specifications of the 19 which are reported in tables 4 and 5.

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6 As noted in the previous section, an optimum currency area or a Mundell-Fleming type of model would predict the same relation between the variability of exchange rates and the correlation of shocks or the variance of shocks. Hence, the empirical validity of these relations cannot be interpreted as a validation of our model.

7 Our results are close to those of Bayoumi and Eichengreen (1996). They also include a coefficient on the sum of the size of both countries and obtain a positive sign. Their reasoning, different from ours, is that larger countries are less dependent on trade and therefore care less about exchange rate variability. They do not however examine a possible non linearity in this relation.

In specification {3} we added an « EMS (narrow band) » dummy for the bilateral exchange rates of the currencies inside the narrow band of the EMS (France, Germany, Benelux, Denmark and Ireland to which we add Austria which in effect has a fixed exchange rate with the DM). Non surprisingly, the EMS dummy comes out very negatively and significatively. More interestingly, its inclusion does not change much the value and the significativity of the coefficients on the size differential in table 4. In table 5, the inclusion of the EMS dummy in specification {3} leads to a lower significativity as the coefficients on $(\text{size small})^2$ and on $(\text{size large})^2$ become significant at the 5% and 10% level respectively.

We also wanted to check the effect of EMS on the variability of the exchange rate of the currencies of the EMS with respect to currencies outside the EMS. This is the closest real life experiment to our question of the consequence of EMU on exchange rate policy. In the theoretical model indeed, a credibly fixed exchange rate system between countries is similar to the formation of an ECB or to an increase in country size. In regression {6}, we therefore added a « EMS (external) » dummy for all bilateral exchange rates involving a currency of the EMS. The coefficient is negative and very significant. We checked whether we were not just picking the fact that some European currencies have been in the « wide band » EMS so that the lower volatility of the external exchange rate of EMS currencies came from lower volatility with these currencies. To do this we added another EMS dummy for bilateral exchange rates of currencies in the narrow band with currencies which at some point during the period have been in the wide band (Italy, Spain, Portugal and UK). The « EMS (wide band) » dummy is negative and significant. More interestingly, the « EMS (external) » dummy stays significant at the 1% level. Hence, EMS currencies have had a lower volatility with currencies not in the EMS[8]. This result is similar in nature to the one obtained by Flood and Rose (1995) who show that the volatility of exchange rates which disappears with a fixed exchange rate is not transferred to some other macro economic variables.

In specification {4}, a dollar dummy was added to see if there is something special about the variability of the dollar exchange rate and whether our results on the effect of size depend on the inclusion of the US which is the largest country and can be considered as a outlier. First, the dollar dummy is not significant. The inclusion of the dollar dummy reduces somewhat the significativity of the $(\text{size differential})^2$ variable but it remains significant at the 5% level. In the specification with the size of countries rather than the size differential, the humped shaped form remains very strong for the small country but disappears somewhat for the large country[9].

A related question is the relation between the status of reserve currencies and country size. There is a strong correlation (although non linear) between country size and the use of the currency as a reserve currency. It may be that reserve currencies which are those of the three biggest countries (USA, Germany, Japan) are less unstable than others and that may explain our hump shape. To test this, we first included in our regressions a variable that measures how important the currency is as a reserve currency. In specification {5} we did this by introducing a variable called "reserves" which is the currency

[8] The results of Artis and Taylor (1994) who are using time series data lead to a similar conclusion.

[9] When we run the regressions without the dollar exchange rates the $(\text{size large})^2$ becomes non significant. However, the hump shape becomes significant again once country fixed effects (see below) are introduced.

composition of reserves of central banks in industrial countries in 1988. For each exchange rate we took the addition of both currencies share. In table 4, the coefficient is not significant and leaves the size differential variables almost unchanged. In table 5 however it is negative and significant and its introduction eliminates the hump for large countries although it does not for small countries.

In the same vein we also wanted to check whether the three reserve currencies (the dollar, the yen and the DM) which also are the currencies of the three largest countries had a specific volatility. We therefore added a separate dummy for all exchange rates that involve the dollar, the yen and the DM. In the specification in terms of size differential, these were not significant. However, in the specification in terms of country size, these were very significant. The result is reported in specification {9} of table 5. The interpretation of these dummies (which are not reported) is not very easy because they interact with the size factor (the coefficients on the size variables change drastically once these dummies are included). The interesting result is that the coefficient on the other variables become all more significant. On the four size variables, the t statistics are all more than 6.

We finally tested for country fixed effects. To do this we included dummies for each country separately and retained country dummies that were significant at the 1% level in all specifications. In the size differential specification, dummies for Australia, UK and Canada exchange rates were significant (their coefficients are not reported). Their inclusion improves the results as the size differential variables becomes significant at the 1% level (specification {8} in table 4). In the specification with country size, only the dummy for Australia was significant in all specifications. Again, its conclusion in regressions{8}, {10} and {11} make all variables significant at the 1% level.

In specification {11}, the "reserves" coefficient is again added. It is not significant and the two humps stay very significant. This suggests that our country size variables pick something more than the status of currencies of large countries as reserve currencies.

One important question is whether the standard deviations of the 210 exchange rates we use are truly independent observations. Intuitively, one can doubt that the volatility of the Austrian Shilling with respect to the dollar is independent of the volatility of the DM with respect to the dollar. Optimally, we should look at the correlation between the movements of the Austrian Shilling/DM exchange rate and the movements of the DM/dollar exchange rate. Only if this correlation is different from zero will the volatility of the Austrian Shilling/dollar be different from the sum of the Austrian Shilling/DM volatility and the DM/dollar volatility[10]. This would require calculating these correlations for all possible combinations. Rather we took an ad-hoc view that independence of movements in bilateral rate is most in question for those currencies that have had a very strong fixed exchange rate regime. We therefore eliminated those currencies for which one of the exchange rates had a standard deviation below 3%[11]. This meant the elimination of

[10] More formely, we can write the variance of the shilling/dollar exchange rate (in terms of the log of the annual change) as:
var(shilling/dollar) = var (shilling/DM) + var (DM/dollar) + 2 cov (shilling/DM; DM/dollar).

[11] We chose this threshold because we did not want to eliminate currencies such as the French Franc or the Canadian dollar.

the Austrian Shilling, the Belgium Franc and the Dutch guilder. We however kept the exchange rates of these currencies with the DM as they may be considered as the only "chosen" exchange rate. We were left with 156 observations. The results are given in tables 6 and 7, specifications {1} to {7} and {1} to {9} respectively. As can be checked, the results are less good than those of the whole sample. The signs are all correct for the size differential specifications (table 6) but the hump effect (the variable on the square of the size differential) is significant at the 1% to 5% level only when country fixed effects are added. For the country size specification (table 7), the hump effect remains strong for the "small" country but is only significant at the 1% or 5% level when the country fixed effects are added.

As one of the objectives of this paper is to analyze what may be some of the future determinants of the Dollar/Euro volatility, we also ran the same regression on a subsample of the exchange rates of currencies with respect to the dollar. Of course this eliminates many observations and we are left with only 20 of them. No need to say that the results should therefore be taken with caution. In specification {9}[12] the results are given for all currencies with respect to the dollar. In specification {10}, they are given only for European currencies. The results are quite good as all the coefficients (except the trade and the output volatility variables) are of the right sign and significant at 1% or 5%. To illustrate the non linearuty of the relation between exchange rate variability for these European currencies and country size, we also provide this relation on graphs 2 and 3. In graph 2 the simple correlation is provided. In graph 3, the variability is corrected by its other determinants (correlation of shocks, variance of shocks and bilateral trade). In both cases, even though the hump shape may not appear obvious (it is however confirmed by the regression analysis), the non linearity comes out very strongly.

IV. IMPLICATIONS FOR THE DOLLAR/EURO EXCHANGE RATE VOLATILITY

In this section we use the empirical results obtained in the previous section to perform a « back of the envelope » exercise of prediction of the likely effect of EMU on the dollar/euro exchange rate volatility. For this we use the results of specifications {2}, {6} and {7} in table 4. The results are given in the table below.

EMU and the volatility with the dollar

	EMU15	EMU11	EMU6	Germany	US			
correlation with the US 80-95	0.42	0.29	0.315	0.362				
standard deviation of growth rates	1.21	1.23	1.20	1.35	2.08			
size difference with the US	13	311	676	1054				
Bilateral trade in % of GDP	3.43	3.13	3.37	3.37	EMU15 3.62	EMU6 1.88	EMU11 2.59	Germany 0.87
predicted standard deviation of exchange rates	0.06 to 0.08	0.09 to 0.11	0.11 to 0.13	0.12 to 0.14 (actual 0.141)				

12 In this case, there is no difference between the interpretation in terms of the size differential or in terms of country size.

See text for explainations.

Whatever the composition of EMU and the regression used, our results predict a decrease of volatility in the exchange rate of the dollar compared to the actual volatilities observed during the 1980-95 period for the DM. In the case of the EMU with 6 countries, the so-called « core », (Benelux, France, Germany, Austria), the volatility would not decrease by a quantitatively significant amount. From 0.141 with the DM, the volatility would decrease to a range of 0.11 to 0.13 depending on the regression used. Note that this decrease is of the same order of magnitude or larger than the predicted decrease in the external exchange rate volatility provided by the narrow band EMS (see coefficient on EMS (external) in equation {7} in tables 6 and 7). In the case of EMU11 (the core + those which want to enter: Italy, Spain, Finland, Ireland, Portugal), the volatility would decrease to a lower range of 0.09 to 0.11. As a comparison, this is similar to the variability of the Sterling with respect to European currencies during the 1980-1995 period. EMU15, would bring a much lower volatility at around 0.06 to 0.08. However, this would still be much more than the volatility of the Canadian dollar with respect to the American dollar which was 4.8% during the period considered.

The lower volatility comes mainly from two different factors. The most important factor quantitatively is by far the size differential factor which goes down with the US. In the case of EMU6, the decrease in size differential has a small quantitative effect on exchange rate variability because at that level of size differential the relation is almost flat. The sharp decrease in exchange rate volatility with EMU15 arises because at that small level of size differential, the predicted volatility is unambiguously on the left side of the hump. The second factor is the increase in trade intensity as Europe becomes a more important trade partner to the US than European countries taken separately. The standard deviation of growth rates of EMU is lower than the standard deviation of growth rates in Germany, hence this tends to lower volatility of the Euro compared to the DM. The higher correlation of shocks in the case of EMU 15 leads to lower volatility. However, our regressions suggest that none of these two factors are quantitatively important.

These results should obviously be used with much caution. The predicted decrease in the volatility for the dollar/Euro exchange rate is much too large to be plausible in the regressions using country size rather than size differential so that we do not report them. Even though the message is the same (the volatility should go down), this suggests that the quantitative impact of the EMU on exchange rate volatility is hard to predict from our regressions. The creation of EMU is such an important change in the policy regime that the Lucas critique also comes to mind. Past behaviour of exchange rates may be a vastly different, once EMU is in place, from those suggested by the past, and we do not know what will be the international role of the Euro. Second, we have made as if the variability of shocks and the correlation of shocks with the US of the EMU6-11 or 15 zone will be the same as today. However, size itself may affect these variables. For example, it can be argued that the EMU zone will be more volatile because the diffusion and amplification of shocks is more important in closed economies[13]. In this case, we would underestimate the volatility of the dollar/Euro exchange rate.

[13] We have however checked that there is no significant correlation between country size and volatility of output.

Finally, there is no existing country of the size of the future possible EMUs except for Japan and the US. This means that our prediction exercise depends very much on the exchange rates that involve these two currencies.

V. CONCLUSION

One of the most commonly heard arguments among politicians in favor of European Monetary Integration is one that is foreign to the economist tool box on monetary union, that is an argument about size. According to Jacques Delors for example, the creation of the euro is “the only way to resist the domination of the dollar”. Other politicians seem to believe in the same vein that « bigger is better ».

In this paper, we have taken politicians seriously. We analyse how the change in economic size of players in international monetary relations implied by the creation of EMU may alter monetary and exchange rate policies. We have shown that theoretically, the relation between size and exchange rate variability is not a simple linear one. Empirically, the prediction of a hump shape relation holds well for exchange rates in industrialised countries and as our results on the prediction of the dollar/euro exchange rate volatility suggest, the impact of size may be quantitatively important. This size effect of EMU on the dollar/euro instability is corroborated by the result that EMS has had a stabilising effect on the exchange rates of currencies in the EMS with respect to currencies not in the EMS.

Our results can be interpreted as describing how the incentives to use monetary policy to influence the exchange rate in order to stabilise output may change with EMU. They can therefore shed some light on the likely political pressures that the independent ECB will have to resist. Some economists and policy makers fear that if the responsibility of the exchange rate policy is in the hands of the governments rather than the ECB, this may lead to conflicts on exchange rate policy and therefore monetary policy. Our results suggest that the problem of possible conflicts between the ECB and the European governments on the management of the exchange rate policy with respect to the dollar may be exaggerated because the increase in size involved in the creation of the EMU will weaken the economic incentive and therefore the political pressures for such manipulations.

APPENDIX :

To derive the size coefficients in the text, we can think of the world as comprised of N identical regions. Regions compete with each other on the basis of real wages so that the per capita supply function in region i has the following form:

$$y_i = (p_i - w_i) - \frac{1}{N-1}\sum_{j \neq i}^{N}(p_j - w_j) + e_i$$

where the coefficient on the real wages of all other regions has been chosen so that at the world level output does not depend on real wages. Now suppose that we divide the world in two countries 1 and 2. They are comprised respectively of n_1 and n_2 regions which have an identical monetary policy and therefore inflation rate, inflation expectations and nominal wages so that:

$$y_1 = \frac{N-n_1}{N-1}(p_1 - w_1) - \frac{N-n_1}{N-1}(p_2 - w_2) + e_1$$

$$y_2 = \frac{N-n_2}{N-1}(p_2 - w_2) - \frac{N-n_2}{N-1}(p_1 - w_1) + e_2$$

If we normalize n_2 to 1 and n_1 to $1/\alpha$, then we get equation (2) in the text.

Table 1

Volatility of bilateral exchange rates: 1980-95

	Austria	Australia	Belgium	Canada	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Japan	Netherlands	New Zealand	Norway	Portugal	Spain	Sweden	Switzerland	UK
Australia	0,190																			
Belgium	0,039	0,191																		
Canada	0,143	0,090	0,154																	
Denmark	0,039	0,187	0,030	0,147																
Finland	0,084	0,159	0,082	0,137	0,088															
France	0,040	0,191	0,025	0,154	0,034	0,087														
Germany	0,006	0,104	0,039	0,145	0,036	0,086	0,040													
Greece	0,092	0,134	0,084	0,111	0,090	0,087	0,095	0,094												
Ireland	0,037	0,181	0,041	0,140	0,044	0,086	0,028	0,039	0,095											
Italy	0,054	0,185	0,058	0,141	0,061	0,076	0,061	0,054	0,091	0,059										
Japan	0,140	0,157	0,140	0,142	0,125	0,140	0,142	0,139	0,139	0,145	0,146									
Netherlands	0,012	0,192	0,037	0,147	0,030	0,086	0,037	0,009	0,095	0,038	0,054	0,135								
New Zealand	0,119	0,133	0,123	0,128	0,115	0,109	0,119	0,119	0,105	0,119	0,131	0,104	0,116							
Norway	0,074	0,140	0,073	0,112	0,074	0,059	0,071	0,076	0,076	0,063	0,082	0,121	0,076	0,088						
Portugal	0,095	0,172	0,073	0,157	0,082	0,108	0,075	0,096	0,088	0,079	0,100	0,145	0,092	0,125	0,089					
Spain	0,076	0,174	0,060	0,143	0,075	0,084	0,068	0,077	0,081	0,061	0,063	0,161	0,078	0,140	0,089	0,078				
Sweden	0,088	0,158	0,075	0,130	0,085	0,058	0,080	0,089	0,082	0,080	0,064	0,132	0,090	0,120	0,060	0,094	0,065			
Switzerland	0,050	0,190	0,068	0,147	0,065	0,083	0,074	0,051	0,097	0,074	0,081	0,133	0,052	0,110	0,084	0,110	0,100	0,103		
UK	0,112	0,155	0,110	0,141	0,114	0,085	0,103	0,114	0,117	0,100	0,104	0,127	0,113	0,099	0,089	0,113	0,108	0,074	0,115	
US	0,139	0,191	0,151	0,048	0,141	0,141	0,149	0,141	0,118	0,137	0,148	0,133	0,142	0,126	0,111	0,162	0,152	0,137	0,144	0,147

Table 2: Bilateral merchandise trade shares (exports+imports) in % of GDP (average: 1980-1995)

80-95	Austria	Australia	Belgium	Canada	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Japan	Netherlands	New Zealand	Norway	Portugal	Spain	Sweden	Switzerland	UK	US
Austria		0,06	0,98	0,08	0,56	0,54	0,31	2,10	0,47	0,54	0,79	0,07	0,81	0,28	0,05	0,66	0,09	0,56	0,68	0,49	0,04
Australia	0,11		0,34	0,27	0,20	0,35	0,15	0,23	0,10	0,45	0,20	0,57	0,37	8,94	0,13	0,12	0,09	0,40	0,36	0,46	0,22
Belgium	1,25	0,23		0,22	1,41	1,06	3,37	3,16	0,98	2,84	1,19	0,12	12,26	0,47	1,36	1,71	0,93	1,96	2,27	2,05	0,20
Canada	0,29	0,51	0,60		0,26	0,34	0,25	0,31	0,16	0,89	0,27	0,46	0,66	0,76	1,05	0,36	0,17	0,48	0,55	0,71	3,15
Denmark	0,45	0,08	0,89	0,06		1,67	0,30	0,89	0,41	0,91	0,29	0,07	1,16	0,16	3,11	0,72	0,21	3,69	0,62	0,67	0,07
Finland	0,36	0,13	0,56	0,06	1,41		0,19	0,44	0,25	0,62	0,17	0,06	0,02	0,74	1,45	0,51	0,17	3,02	0,39	0,50	0,05
France	2,29	0,58	19,58	0,53	2,77	2,12		4,71	2,85	6,71	4,69	0,34	7,55	0,77	3,17	6,91	5,07	2,76	6,15	3,60	0,52
Germany	20,77	1,20	24,50	0,88	10,90	6,43	6,29		6,96	10,37	6,29	0,80	22,57	1,52	8,06	8,46	4,46	8,29	16,22	5,65	0,87
Greece	0,25	0,03	0,41	0,02	0,27	0,20	0,20	0,37		0,31	0,39	0,04	0,53	0,11	0,08	0,11	0,12	0,17	0,20	0,16	0,02
Ireland	0,15	0,07	0,61	0,07	0,31	0,25	0,25	0,29	0,16		0,15	0,05	0,79	0,10	0,36	0,26	0,17	0,36	0,26	1,72	0,09
Italy	4,81	0,66	5,71	0,46	2,20	1,53	3,87	3,88	4,53	3,25		0,20	4,87	0,78	1,15	3,75	2,58	1,90	6,46	2,09	0,37
Japan	1,49	6,31	2,00	2,67	1,88	1,72	0,96	1,66	1,46	3,59	0,68		2,50	7,11	1,51	1,10	0,69	1,47	2,74	1,67	2,52
Netherlands	1,49	0,36	17,57	0,34	2,64	0,04	1,86	4,17	1,82	5,28	1,46	0,22		0,39	2,56	2,20	1,04	2,33	1,85	2,39	0,25
New Zealand	0,08	1,37	0,11	0,06	0,06	0,31	0,03	0,04	0,06	0,10	0,04	0,10	0,06		0,03	0,04	0,02	0,08	0,06	0,17	0,05
Norway	0,03	0,05	0,79	0,22	2,88	1,59	0,32	0,61	0,12	0,98	0,14	0,05	1,04	0,08		0,68	0,14	3,70	0,30	1,24	0,06
Portugal	0,28	0,03	0,57	0,04	0,38	0,32	0,39	0,36	0,09	0,41	0,26	0,02	0,51	0,06	0,39		0,00	0,40	0,34	0,35	0,03
Spain	0,24	0,13	2,00	0,13	0,71	0,69	1,86	1,23	0,62	1,67	1,15	0,09	1,55	0,20	0,51	0,01		0,79	0,94	1,05	0,17
Sweden	0,74	0,28	2,02	0,18	6,05	5,88	0,49	1,11	0,43	1,71	0,41	0,09	1,68	0,37	6,55	1,24	0,38		0,99	1,14	0,15
Switzerland	0,93	0,27	2,44	0,21	1,06	0,79	1,14	2,25	0,51	1,28	1,45	0,18	1,39	0,28	0,54	1,12	0,47	1,03		0,86	0,15
UK	2,90	1,48	9,62	1,20	4,98	4,37	2,91	3,42	1,84	37,40	2,05	0,48	7,81	3,56	9,95	5,02	2,31	5,16	3,73		0,79
US	1,65	4,51	5,92	33,83	3,13	2,85	2,66	3,37	1,45	12,08	2,32	4,67	5,30	6,70	3,30	2,84	2,32	4,34	4,28	5,01	

The country to which the statistic applies is the one indicated at the top of the column.

Table 3: Correlation of growth rates: 1980-1995

80-95	Austria	Australia	Belgium	Canada	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Japan	Netherlands	New Zealand	Norway	Portugal	Spain	Sweden	Switzerland	UK
Australia	-0,027																			
Belgium	0,829	0,120																		
Canada	-0,068	0,834	-0,021																	
Denmark	-0,017	0,220	-0,160	0,234																
Finland	0,128	0,510	0,332	0,501	0,166															
France	0,618	0,160	0,662	0,129	0,058	0,577														
Germany	0,730	0,196	0,539	0,330	0,204	0,079	0,605													
Greece	0,481	0,178	0,512	0,250	0,212	0,197	0,526	0,609												
Ireland	0,465	0,411	0,503	0,063	-0,079	0,199	0,382	0,317	0,027											
Italy	0,580	0,323	0,693	0,433	0,118	0,611	0,723	0,664	0,574	0,259										
Japan	0,491	0,029	0,482	0,103	-0,148	0,180	0,574	0,511	0,460	0,073	0,535									
Netherlands	0,714	0,300	0,488	0,299	0,236	0,071	0,465	0,883	0,492	0,447	0,567	0,359								
New Zealand	-0,431	0,649	-0,283	0,570	0,380	0,276	-0,236	-0,174	-0,153	0,070	-0,173	-0,258	-0,186							
Norway	-0,115	0,227	-0,246	0,336	0,568	-0,067	-0,420	0,134	0,011	-0,198	0,080	-0,414	0,207	0,292						
Portugal	0,247	-0,163	0,214	0,003	-0,082	0,233	0,535	0,296	0,165	-0,170	0,545	0,404	0,286	-0,522	-0,203					
Spain	0,638	0,064	0,616	0,182	0,028	0,396	0,784	0,667	0,395	0,274	0,762	0,663	0,577	-0,437	-0,287	0,592				
Sweden	0,269	0,470	0,414	0,539	0,434	0,773	0,613	0,494	0,344	0,252	0,803	0,344	0,417	0,235	0,202	0,278	0,625			
Switzerland	0,473	0,361	0,452	0,463	-0,099	0,558	0,518	0,481	0,439	0,074	0,770	0,600	0,481	-0,147	0,069	0,554	0,506	0,526		
UK	0,069	0,422	0,021	0,562	0,546	0,524	0,377	0,240	0,132	-0,027	0,352	0,110	0,240	0,223	0,053	0,247	0,527	0,567	0,150	
US	-0,012	0,782	-0,070	0,897	0,329	0,313	0,164	0,362	0,207	0,101	0,273	0,070	0,470	0,587	0,369	-0,128	0,151	0,464	0,294	0,548

Table 4

dependent variable: variability of exchange rates 1980-95

	{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}country fixed effects
sum of standard deviations	0.010***	0.011***	0.0064**	0.011***	0.011***	0.002	0.003	0.006***
	(3.60)	(3.96)	(2.40)	(3.96)	(3.96)	(0.73)	(0.97)	(2.81)
trade	-0.0027***	-0.0028***	-0.002***	-0.0028***	-0.0028***	-0.0016***	-0.0015***	-0.0025***
	(-6.43)	(-6.68)	(-4.73)	(-6.69)	(-6.58)	(-4.00)	(-3.68)	(-8.21)
correlation	-0.012*	- 0.012*	-0.012*	-0.012*	-0.012*	-0.018***	-0.016**	-0.020***
	(-1.49)	(-1.49)	(-1.64)	(-1.50)	(-1.49)	(-2.46)	(-2.17)	(-3.48)
size differential	$1.3x10^{-5}$ ***	$2.6x10^{-5}$ ***	$2.18x10^{-5}$ ***	$2.75x10^{-5}$***	$2.59x10^{-5}$***	$1.87x10^{-5}$ ***	$1.89x10^{-5}$ ***	$2.61x10^{-5}$ ***
	(7.4)	(4.02)	(3.64)	(3.76)	(3.91)	(3.21)	(3.26)	(5.52)
(size differential)^2		$-2.9x10^{-9}$ **	$-2.5x10^{-9}$**	$-3.9x10^{-9}$**	$-3.3x10^{-9}$**	$-1.9x10^{-9}$*	$-2.1x10^{-9}$*	$-2.5x10^{-9}$***
		(-1.98)	(-1.84)	(-1.64)	(-1.83)	(-1.49)	(-1.62)	(-2.39)
EMS (narrow band)			-0.053***			-0.066***	-0.067***	
			(-7.00)			(-8.24)	(-8.39)	
EMS (wide band)							-0.013**	
							(-1.90)	
EMS (external)						-0.019***	-0.014***	
						(-3.99)	(-2.70)	
dollar				0.013				
				(0.52)				
reserves					0.0001			
					(0.34)			
n. observations	210	210	210	210	210	210	210	210
$\overline{R}^2$	0.36	0.38	0.50	0.38	0.38	0.54	0.54	0.69

The t. statistic is in bracket: One, two and three asterisks indicate that the coefficient is significant at 10%, 5%, 1% probability level, respectively.

Table 5
dependent variable: variability of exchange rates 1980-95

	{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}country fixed effects	{9}reserve currencies	{10} country fixed effects+ reserve currencies	{11} co fixed ef reserve currenci
sum of SD	0.012***	0.014***	0.0095***	0.014***	0.014***	0.0052**	0.0064**	0.013***	0.015***	0.014***	0.014**
	(4.32)	(5.16)	(3.50)	(5.11)	(5.02)	(1.82)	(2.22)	(5.95)	(5.89)	(6.55)	(6.58)
trade	-0.0027***	-0.0028***	-0.0019***	-0.0027***	-0.0025***	-0.002***	-0.0015***	-0.0024***	-0.0024***	-0.0024***	-0.0027
	(-6.62)	(-6.85)	(-4.97)	(-6.38)	(-5.78)	(-4.25)	(-3.89)	(-7.38)	(-5.97)	(-6.34)	(-6.38)
correlation	-0.015**	- 0.021***	-0.019***	-0.021***	-0.021***	-0.024***	-0.022***	- 0.024***	- 0.031***	- 0.031***	- 0.030*
	(-1.91)	(-2.60)	(-2.58)	(-2.53)	(-2.64)	(-3.32)	(-3.04)	(-3.77)	(-4.08)	(-4.97)	(-4.89)
size small	1.9x10^{-5}**	6.2x10^{-5}***	4.7x10^{-5} ***	6.2x10^{-5}***	6.6x10^{-5}***	4.6x10^{-5}***	5.0x10^{-5}***	5.0x10^{-5}***	2.0x10^{-4}***	1.5x10^{-4}***	1.5x10^{-}
	(1.98)	(3.17)	(2.64)	(3.19)	(3.39)	(2.65)	(2.93)	(3.23)	(7.11)	(6.15)	(6.09)
(size small)^2		-2.5x10^{-8}***	-2x10^{-8}**	-2.6x10^{-8}***	-2.6x10^{-8}***	-2x10^{-8}**	-2.1x10^{-8}***	-1.9x10^{-8}***	-2.9x10^{-7}***	-1.3x10^{-7}***	-1.3x10
		(-2.59)	(-2.20)	(-2.60)	(-2.64)	(-2.26)	(-2.45)	(-2.48)	(-6.73)	(-5.48)	(-5.48)
size large	1.2x10^{-5}***	2.3x10^{-5}***	2.0x10^{-5}***	1.8x10^{-5}*	1.8x10^{-5}***	1.7x10^{-5}***	1.8x10^{-5}***	2.6x10^{-5}***	1.9x10^{-5}***	1.4x10^{-4}***	1.4x10^{-}
	(6.70)	(3.37)	(3.20)	(1.42)	(2.57)	(2.80)	(2.97)	(4.91)	(6.50)	(5.62)	(5.60)
(size large)^2		-2.4x10^{-8}**	-2x10^{-8}*	-4.3x10^{-9}	-7.9x10^{-9}	-1.3x10^{-8}*	-1.9x10^{-8}*	-2.9x10^{-8}***	-1.9x10^{-7}***	-1.2x10^{-7}***	-1.2x10
		(-1.72)	(-1.64)	(-0.09)	(-0.34)	(-1.30)	(-1.58)	(-2.65)	(-6.18)	(-4.94)	(-4.95)
EMS (narrow band)			-0.049***			-0.061***	-0.062***				
			(-6.51)			(-7.72)	(-7.88)				
EMS (wide band)							-0.016***				
							(-2.47)				
EMS (external)						-0.017***	-0.012**				
						(-3.86)	(-2.29)				
dollar				-0.023							
				(-0.44)							
reserves					-0.0008**						0.0009
					(-1.68)						(0.82)
n. observations	210	210	210	210	210	210	210	210	210	210	210
$\overline{R}^2$	0.40	0.43	0.53	0.44	0.44	0.57	0.58	0.65	0.54	0.70	0.70

The t. statistic is in bracket: One, two and three asterisks indicate that the coefficient is significant at 10%, 5%, 1% probability level, respectively.

Table 6: Subsamples

dependent variable: variability of exchange rates 1980-95

	{1}	{2}	{3}	{4}	{5}	{6}	{7}country fixed effects	{8}country fixed effects	{9}
sum of SD	0.0077***	0.0089***	0.006**	0.009**	0.004*	0.005*	0.005**	0.007*	0.008**
	(2.53)	(2.79)	(2.04)	(2.81)	(1.39)	(1.51)	(2.18)	(1.75)	(1.95)
trade	-0.003***	-0.003***	-0.002***	-0.003***	-0.002***	-0.002***	-0.004***	0.0005	0.0006
	(-6.54)	(-6.66)	(-4.88)	(-6.67)	(-4.38)	(-4.17)	(-10.85)	(0.46)	(0.61)
correlation	- 0.0015	- 0.0008	-0.0029	-0.001	-0.006	-0.005	-0.005	-0.032**	-0.034**
	(-0.16)	(-0.09)	(-0.34)	(-0.11)	(-0.70)	(-0.59)	(-0.83)	(-2.65)	(-2.46)
size differential	1.19×10^{-5} ***	2.07×10^{-5}***	2.12×10^{-5} ***	2.24×10^{-5}***	2.05×10^{-5}***	2.05×10^{-5}***	2.61×10^{-5}***	1.14×10^{-4}***	3.92×10^{-4}***
	(6.22)	(2.83)	(3.09)	(2.82)	(3.01)	(3.03)	(4.94)	(2.91)	(2.74)
(size differential)^2		-2.0×10^{-9}	-2.4×10^{-9}*	-3.0×10^{-9}*	-2.3×10^{-9}*	-2.4×10^{-9}*	-2.9×10^{-9}***	-1.6×10^{-8}***	-5.6×10^{-8}**
		(-1.25)	(-1.58)	(-1.24)	(-1.56)	(-1.63)	(-2.53)	(-2.97)	(-2.23)
EMS (narrow band)			-0.053***		-0.049***	-0.051***			
			(-4.69)		(-4.35)	(-4.52)			
EMS (wide band)						-0.013			
						(-1.57)			
EMS (external)					-0.011***	-0.007			
					(-1.95)	(-1.14)			
dollar				0.014					
				(0.55)					
n. observations	156	156	156	156	156	156	156	20	16
$\overline{R}^2$	0.36	0.37	0.45	0.37	0.46	0.47	0.68	0.91	0.59

The t. statistic is in bracket: One, two and three asterisks indicate that the coefficient is significant at 10%, 5%, 1% probability level, respectively.

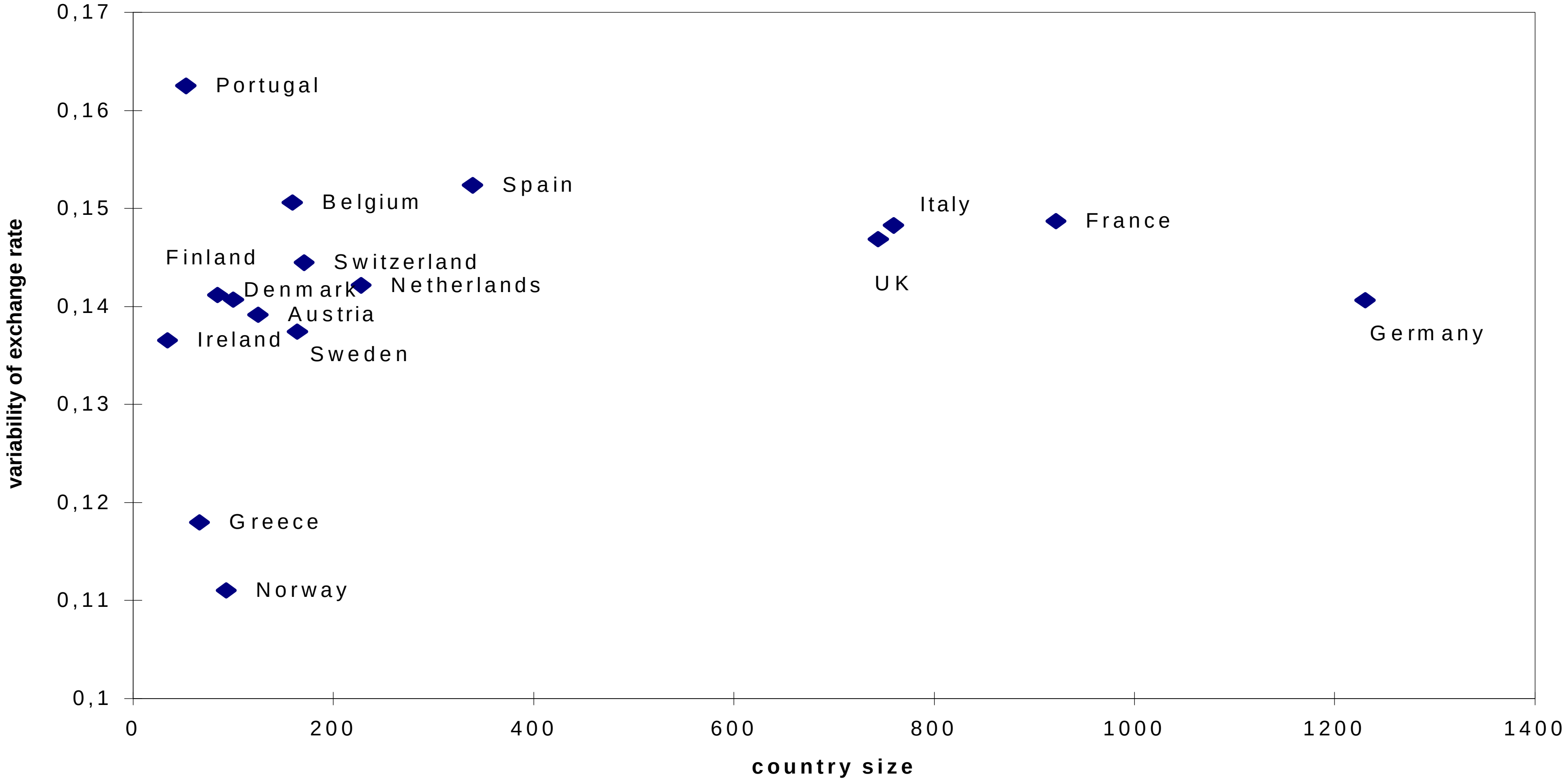
Table 7: Subsamples

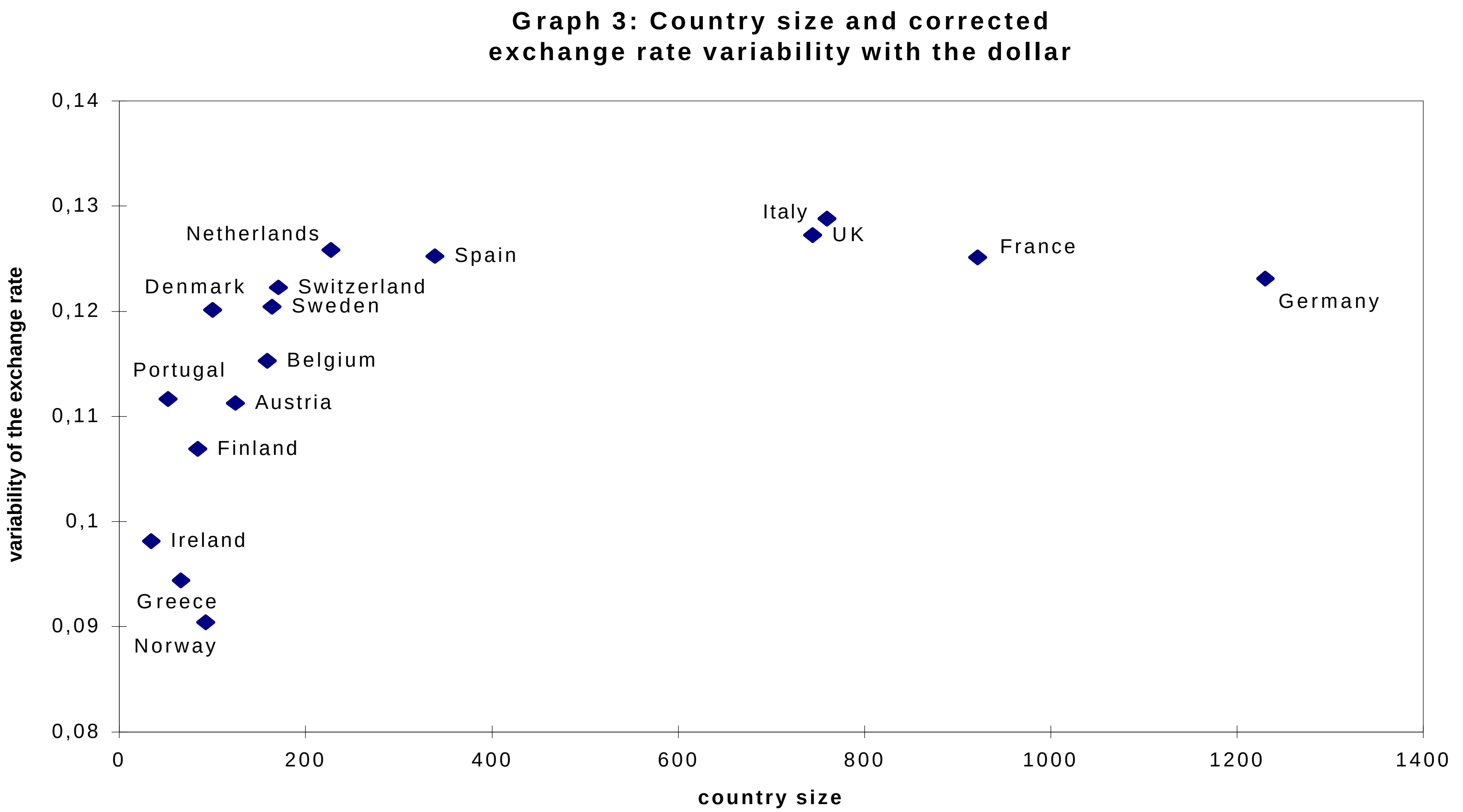
dependent variable: variability of exchange rates 1980-95

	{1}	{2}	{3}	{4}	{5}	{6}	{7}country fixed effects	{8}reserve currencies	{9} country fixed effects+ reserve currencies
sum of SD	0.01***	0.012***	0.009***	0.012***	0.006**	0.0070**	0.012***	0.012***	0.011***
	(3.22)	(3.78)	(3.02)	(3.59)	(1.93)	(2.19)	(4.66)	(3.83)	(4.57)
trade	-0.0029***	-0.0029***	-0.0022***	-0.0028***	-0.002***	-0.0017***	-0.0025***	-0.0024***	-0.0021***
	(-6.64)	(-6.64)	(-4.94)	(-6.09)	(-4.05)	(-3.75)	(-7.17)	(-5.44)	(-5.85)
correlation	-0.004	- 0.009	-0.010	-0.008	-0.016**	-0.015**	- 0.015**	- 0.020***	- 0.021***
	(-0.51)	(-1.01)	(-1.19)	(-0.86)	(-1.87)	(-1.82)	(-2.03)	(-2.35)	(-2.98)
size small	$1.35x10^{-5}$*	$4.5x10^{-5}$**	$3.8x10^{-5}$ **	$4.5x10^{-5}$**	$4.0x10^{-5}$**	$4.4x10^{-5}$***	$4.0x10^{-5}$***	$1.8x10^{-4}$***	$1.3x10^{-4}$***
	(1.47)	(2.33)	(2.06)	(2.34)	(2.25)	(2.48)	(2.63)	(5.77)	(4.83)
(size small)^2		$-1.8x10^{-8}$**	$-1.5x10^{-8}$**	$-2.6x10^{-8}$**	$-1.6x10^{-8}$**	$-1.7x10^{-8}$**	$-1.5x10^{-8}$**	$-1.7x10^{-7}$***	$-1.1x10^{-7}$***
		(-1.87)	(-1.66)	(-1.88)	(-1.81)	(-1.97)	(-1.94)	(-5.50)	(-4.21)
size large	$1.09x10^{-5}$***	$1.8x10^{-5}$**	$1.9x10^{-5}$***	$7.5x10^{-6}$	$1.9x10^{-5}$***	$1.9x10^{-5}$***	$2.2x10^{-5}$***	$1.7x10^{-4}$***	$1.1x10^{-4}$***
	(5.69)	(2.36)	(2.72)	(0.53)	(2.77)	(2.83)	(3.66)	(5.16)	(4.23)
(size large)^2		$-1.5x10^{-9}$	$-2x10^{-9}$*	$2.6x10^{-9}$	$-2.x10^{-8}$*	$-2.2x10^{-8}$*	$-2.2x10^{-8}$**	$-1.6x10^{-7}$***	$-1.0x10^{-7}$***
		(-0.99)	(-1.40)	(0.52)	(-1.49)	(-1.62)	(-1.81)	(-5.07)	(-3.78)
EMS (narrow band)			-0.049***		-0.062***	-0.063***			
			(-4.47)		(-5.54)	(-5.64)			
EMS (wide band)						-0.015*			
						(-1.64)			
EMS (external)					-0.019***	-0.014**			
					(-3.56)	(-2.23)			
dollar				-0.048					
				(-0.86)					
n. observations	156	156	156	156	156	156	156	156	156
$\overline{R}^2$	0.39	0.41	0.48	0.42	0.53	0.54	0.63	0.52	0.68

The t. statistic is in bracket: One, two and three asterisks indicate that the coefficient is significant at 10%, 5%, 1% probability level, respectively.

Graph 2: Country size and exchange rate variability with the dollar




Graph 3: Country size and corrected exchange rate variability with the dollar
0,14
0,13
0,12
0,11
0,1
0,09
0,08
variability of the exchange rate
0
200
400
600
800
1000
1200
1400
country size
Netherlands
Spain
Italy
UK
France
Germany
Denmark
Switzerland
Sweden
Portugal
Belgium
Austria
Finland
Ireland
Greece
Norway

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