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This paper deals with Euro introduction and ask whether it is likely to increase the exchange rates volatility on a world-wide scale. Following this purpose, we present a three country-model (US, Germany and France) and compare the exchange rate volatility according to the nature of the shock (demand or supply shock) and to the exchange rate regime in Europe (flexible, EMS or EMU). Each country is represented by two authorities: a central bank and a government (a single central bank and two governments in Europe in the case of EMU). Within this framework, we compute Nash-equilibria.

In theory, the exchange rate of a large closed country fluctuates more than the exchange rate of a small open country (the size effect), but results are ambiguous in the specific case of the Euro. An increase in volatility would only occur after demand and external supply shocks. Volatility would be reduced following internal supply shocks. The conclusions are the opposite if the sensitivity of intra-European trade to relative prices is particularly strong. In the case of common shocks in Europe, the excess of volatility would help economic stabilisation. As for asymmetric shocks (hitting only one country), the Euro would fluctuate less than the currency of the hit country in the previous monetary system (EMS), but this stability would harm economic stabilisation, as loss functions show.

We note also that the independence of the ECB could lead to strong variations of the Euro after inflationary shocks if the ECB and European governments do not share the same inflation target. The constraints on fiscal policies which are induced by the Stability pact could make more active monetary policies necessary: these would be a source of instability for the Euro.

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Discussing Euro volatility

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The introduction of the Euro will be such an innovation that it should substantially change the way the international monetary system works. The GDP of the forthcoming eleven countries of the Euroland will be worth 80% of the US one and double the Japanese one. Their degree of openness will represent 14 % of their GDP, when France's or Germany's were up 23 %, and 28 % as a European mean (see table 1).

Organisation and interactions between monetary and fiscal policies have long been the subject of an abundant literature: internal European relationships as well as external links with the US or Japan gave rise to numerous studies. Two topics have recently emerged: the valuation of the future Euro's exchange rate - the strong or weak currency question - and that currency variability. We shall be dealing here with this second issue: will the creation of the Euro contribute to increase world-wide exchange rate volatility? Usually, economists expect that the European Central Bank (ECB) will manage the Euro in order to pursue domestic goals, especially to fight inflation, and will not therefore give much attention to the external stability of the currency. Hence, skeptics fear that the Euro may be extremely volatile: the three areas (surrounding respectively the US, Europe and Japan) would undergo large fluctuations of the exchange rates, and these would increase global uncertainty and be unfavourable to the growth of international trade[1]. Some recent papers[2] reach the opposite conclusion: we believe that this major topic deserves an assessment.

❖ This paper was presented during the Journees Internationales d'Economie Monetaire et Bancaire in Toulouse, France, June 1998. We thank participants for their remarks and especially Agnes Benassy.

[1] How exchange rate volatility impinges on international trade is discussed in IMF (1984) and Krugman (1989).

[2] Artus (1997, a and b), Benassy et al. (1997), Cohen (1997), Martin (1997).

*1. Degree of openness in 1996**
in % of GDP

	Importations	Exportations
USA	13.0	11.4
Japan	9.4	10.0
Germany	24.2	23.0
France	21.4	24.0
Euroland 11	27.3	29.8
Euro 11 (intra-area trade excluded)	13.4	14.4

** trade on goods and services.*

Source : OECD, authors' calculations.

In the economic literature, six different factors might increase or decrease the Euro-Dollar exchange rate volatility in comparison with the present volatility of European currencies. It is nevertheless difficult to compute the relative weights of these factors.

The first one is the pure size effect, hence linked in part to the degree of openness. The Euroland will be much less open to international trade than each of the countries that will constitute it. A large and relatively closed country can use its interest rate to stabilise the activity level or inflation ; it does not have to worry about the consequences of its choices on the exchange rate; to a certain extent, exchange rate fluctuations are painless and can be disregarded. On the contrary, a small open country will be more concerned with the stability of the exchange rate in order to avoid inflationary shocks (in case of a depreciation) or trade shocks (in case of an appreciation). Euro's introduction would then entail large fluctuations between the dollar and the Euro because Central bankers or governments would disregard exchange rate stability.

The second is linked to the automatic co-operation effect which occurs after a symmetric shock (hitting homogeneously all EU countries). In such a situation, the ECB will not react as national central banks would do in a flexible exchange rate regime because the ECB knows that its action will impinge on EU as a whole, whereas each national central bank could think, which would be misleading, that it is the sole bank running an economic policy. After a common inflationary shock, the ECB will increase the interest rate less than a national central bank would do since an appreciation of the Euro will have less disinflationary effects in the EU than an increase of the mark had on the German inflation. Being conscious of this effect may limit the use of monetary policy: it would be an argument in favour of stability.

The third comes from the uniqueness of the nominal interest rate in the EU: both in case of an asymmetric shock or if EU countries cope with different economic conditions, the European monetary policy will be limited. ECB's monetary impotence in this context would be another reason for exchange rate stability.

Further, it should be reminded that EMU take the place of an asymmetric fixed exchange rate regime, the EMS. Following an idiosyncratic shock, the ECB will react according to the average European economic situation, whereas the Bundesbank's behaviour was only taking the German situation into account. Hence, EMU will be more stable than EMS if idiosyncratic shocks hit especially Germany, but less stable if shocks mainly occur outside Germany. On the contrary, if shocks are symmetric, the ECB should have the same behaviour as the Bundesbank's, at least if the latter was conscious that the other European central banks were following its policy to stabilise their exchange rate with the DM[3]. In this case, Euro's volatility will be the same as that of hard EMS currencies: an increase in volatility should have already been observed during the EMS.

EMU does not have size effects only; it is also characterised by a new type of European economic policies' organisation. The central bank independence introduces risks of conflict between monetary and fiscal policies. If it occurs, it will drive up both interest rates and Euro's exchange rate; these risks are a source of instability.

In order to circumvent those risks, the Stability Pact imposes strong restrictions on fiscal policies and leaves the field open to monetary policy. The sole use of monetary policy should necessitate large swings of the European interest rate after a demand shock. This would be another source of instability for the Euro. *A contrario*, after an inflation shock, the Stability Pact would prevent bad strategies, such as a very restrictive monetary policy associated with a lax fiscal policy; the Pact would then reduce volatility.

Last, the link between the variability of the exchange rate and the macroeconomic stabilisation effect of economic policies need an assessment. In some cases where countries face different economic situations, a large volatility makes economic stabilisation better; in other cases, it reflects bad policies: governments and/or central bankers try to export unemployment or inflation towards their trade and financial partners, in pure vain. We shall now study in more details those different elements; for this purpose, we use two models: first, we analyse the situation of one country in the open economy; second, we use a three-country model in which two of them are linked by an exchange rate agreement[4].

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[3] See Sterdyniak and Villa (1993, a).

[4] We present empirical evaluations of some currencies' volatility between 1973 and 1997 in the appendix. They confirm that volatility is higher the bigger the countries.

Size and volatility

We use here a simple model to describe the short run equilibrium of a country in the world economy (see box 1). This model is of the Keynesian type: wages are sticky, production is kept in line with demand. Shocks are perceived by markets as temporary. The model respects uncovered interest rate parity. The country we consider may be small and open (the degree of openness n is 0.2), or large and closed (n is 0.1). Policymakers in this country can manage two instruments: public expenditures and the nominal interest rate. For a given increase in production, fiscal policy is more inflationary in the large than in the small country, but trade deficit is smaller (see table B1). As for monetary policy, it is less inflationary in the big country, but it improves trade balance less.

After a shock has occurred, both authorities minimise a loss function which depends on the social planners' willingness to maintain economic activity, curb inflation, or fight against trade deficit, taking into account their relative preferences for each target and their point of view on the functioning of the economy . We will distinguish the case in which both policymakers use fiscal and monetary policies simultaneously from the situation in which they use monetary policy only, either because of the existence of limits on fiscal policy (Stability Pact), or because the latter is less efficient on the overall economic situation (because of long implementation delays, possible irreversibility).

First, we consider the pure size effect. With our model, the more closed a country, the more its exchange rate varies after a shock[5]. As a matter of fact, the impact of exchange rate variations on output, inflation or trade balance depends on n s, where s is the nominal exchange rate and n is the degree of openness. After a shock, policymakers will move s the more, the less n, i.e. the more open the economy[6].

[5] Box 2 gives explicit solutions for a simplified version of our model.

[6] Artus (1997, a, b) finds the same result. Unfortunately, in his first paper, the model is inconsistent: first, the exchange rate level depends on money supply whereas the central banker manages the interest rate; second, the influence of the degree of openness is taken into account in the inflation equation but not in the trade balance's. In his second paper, Artus introduces in an arbitrary manner a modification in the Fed's loss function after the Euro has been created: no rigourous comparison can be elaborated in this context.

Box 1: A simple model for a country in the open economy

The economy is described by the following six equations:

(1) Demand : $y = d + g + cy - \sigma r + b$ with $\sigma = 0.25$; $c = 0.5$

(2) Trade balance: $b = n(y^* - y) + n\delta(p^* + s - p)$ with $n = 0.1$ or 0.2 ; $\delta = 1.5$

(3) Production prices: $p = vy + w$ with $v = 0.25$

(4) Consumer prices: $q = n(p^* + s) + (1 - n)p$

(5) Interest rate parity: $s = r^* - r$

(6) Loss function: $L = y^2 + \alpha q^2 + \beta b^2$ with $\alpha = 2$; $\beta = 3$

The model is a short term one. Output is driven by the level of demand. Wages are supposed to be sticky. d and w represent demand and supply shock respectively. Economic agents forecast that these shocks are temporary and that the exchange rate will return to its initial value after one period. The degree of openness n can be equal to 0.1 (relatively large and closed country) or 0.2 (relatively small and open country). An increase in the nominal exchange rate, s, is a depreciation of the currency. Other variables have the standard meaning.

Table B1 sums up the impacts of both economic instruments. Fiscal policy's impact is higher the larger the country (the weaker the external constraint). Monetary policy's impact is greater the smaller the country (the larger the competitive gains from a depreciation).

Policymakers use their instruments in order to minimise their loss function. They manage public expenditures g so that :

$$\frac{\delta L}{\delta g} = 2\left(y\frac{\delta y}{\delta g} + \alpha q\frac{\delta q}{\delta g} + \beta b\frac{\delta b}{\delta g} \right) = 0 .$$

Their actions depend on their relative reluctance towards inflation and trade imbalance (summing up in α and β) and on their perception of the national macroeconomic functioning (summing up in $\frac{\delta y}{\delta g}, \frac{\delta q}{\delta g}, \frac{\delta b}{\delta g}$). For the sake of simplicity, we will consider that their perception corresponds to reality so that the $\frac{\delta y}{\delta g}, \frac{\delta q}{\delta g}, \frac{\delta b}{\delta g}$ are those available in table B1.

In the case of a large country, policymakers do use g and the interest rate r so that at stationary state:

$1.569y + 2 * 0.353 * q - 3 * 0.216b = 0$ for g

$0.627y + 2 * 0.241 * q + 3 * 0.064b = 0$ for r

B1. Impacts of economic policy's instruments

	Large country n = 0.1		Small country n = 0.2	
	g = 1	r = 1	g = 1	r = 1
y	1.569	– 0.627	1.290	– 0.710
q	0.353	– 0.241	0.258	– 0.342
b	– 0.216	– 0.064	– 0.355	– 0.105
s	0	1	0	1

In the case of a private demand shock (see table 2), fiscal policy alone is able to stabilise the economy perfectly, without any variations in the interest rate nor the exchange rate[7]. If policymakers do use monetary policy only, they have to reduce the interest rate in order to depreciate the currency. This policy leads to higher inflation and an improvement in the trade balance; both effects are more substantial if the country is small. Hence, the variations of the interest and exchange rates will be higher in a large country. The rise in the exchange rate volatility will help this country to stabilise its economy in a more optimal way: its losses are smaller *ex post*.

In the case of an inflation shock (see table 3), the authorities of a large country will raise their interest rate more than a small country's; the appreciation of the currency will be higher in the former. Unfortunately, the monetary instrument is less powerful in the large country: the rise in the exchange rate reduces prices less the more closed the country. Therefore, the exchange rate varies more in the large country and its loss is bigger. If policymakers use fiscal policy, they will manage a restrictive monetary policy (to curb inflation through an appreciation) and an expansive fiscal policy (to bolster activity level). This policy strategy increases exchange rates instability, especially in the large country, but it is rewarded by a better stabilisation in terms of output and inflation.

In the case of a trade shock (see table 4), the big country has to depreciate its currency more than the small one in order to curb its trade deficit. If both policymakers intervene, a positive monetary policy and a restrictive fiscal policy ought to be implemented: this will be costly because of the depreciation which will be stronger the larger the country.

2. Demand shock: d = – 1 %

	Large country n = 0,1			Small country n = 0,2		
	Initial shock	Use of r	Use of g and r	Initial shock	Use of r	Use of g and r
g	0	0	1	0	0	1
r	0	– 2.131	0	0	– 1.273	0
y	– 1.569	– 0.231	0	– 1.290	– 0.387	0
q	– 0.353	0.161	0	– 0.258	0.177	0
b	0.216	0.351	0	0.355	0.488	0
s	0	2.131	0	0	1.273	0
L	2.849	0.476	0	2.176	0.928	0

[7] The rise in public expenditures compensates exactly and immediately the decrease in private demand. Production is kept at the stationary-state level: the interest rate is constant since production, inflation and trade balance are fixed.

3. Supply shock: w = 1 %

	Large country n = 0,1			Small country n = 0,2		
	Initial shock	Use of r	Use of g and r	Initial shock	Use of r	Use of g and r
g	0	0	0.425	0	0	0.131
r	0	0.456	1.363	0	0.206	0.373
y	– 0.235	– 0.522	– 0.423	– 0.387	– 0.533	– 0.492
q	0.847	0.737	0.425	0.723	0.652	0.629
b	– 0.118	– 0.147	– 0.296	– 0.194	– 0.215	– 0.279
s	0	– 0.456	– 1.363	0	– 0.206	– 0.373
L	1.532	1.423	1.336	1.306	1.274	1.258

4. Trade shock: b = – 1 %

	Large country n = 0,1			Small country n = 0,2		
	Initial shock	Use of r	Use of g and r	Initial shock	Use of r	Use of g and r
g	0	0	– 1.219	0	0	– 0.579
r	0	– 2.499	– 5.091	0	– 1.681	– 2.418
y	– 1.569	– 0.001	– 0.282	– 1.290	– 0.097	– 0.321
q	– 0.353	0.250	0.446	– 0.258	0.317	0.419
b	– 0.784	– 0.625	– 0.198	– 0.645	– 0.469	– 0.186
s	0	2.499	5.091	0	1.681	2.418
L	4.555	1.297	0.594	3.047	0.870	0.559

These first results confirm that the currency of a big country should show more variability than a small country's; this increased volatility is necessary to reduce the consequences of various shocks. It also appears that a large country suffers relatively less from the effects of a private demand shock because it can be smoothed by a monetary policy; though, it is more affected by an inflation or a trade shock. A small country is in a better position to reduce the effects of the two latter shocks by an exchange rate modification. The Euro should be a relatively more volatile currency.

Ph. Martin (1997) considers the opposite result. According to him, « *a large country is less encouraged to use monetary policy in a strategic way in order to stabilise its economy that a smaller country, because its production depends less on the exchange rate than the small one. A large country should then have a more stable exchange rate than a small country* ». In Martin's model, Purchasing Power Parity holds: when a country depreciates its currency by 10%, it undergoes a price level increase of 10%, whatever its size. Firms decide to produce in countries offering the smallest real wages. The competitiveness improvement due to a devaluation is larger the smaller the country:

if a country represents 1% of world production, its firms will make gains in competitiveness over 99% of their external competitors. If it represents up to 50% of world production, they will make gains over 50% only of their competitors. A small open country tends therefore to devaluate its currency more often because its production earnings are higher than a large country's for the same cost in terms of inflation.

His model can be rewritten very simply. Production is stronger the smaller the real wage: $y = v(1-t)(p - w_0)$, where t is the weight of the country in terms of world production. Prices follow the exchange rate according to PPP, $p = s$, while nominal wage is sticky in the short run. The loss function is: $L = y^2 + \alpha p^2$.

The resulting minimisation gives: $s = w_0(1-t)^2v^2 / (a + (1-t)^2v^2)$.

After a supply shock on w_0, the exchange rate moves the more the smaller t, hence the smaller the country. If $a = 1$ and $v = 1$, $s = 0.5w_0$ if $t = 0$, and $s = 0.2w_0$ if $t = 0.5$.

Both models' realism must be compared. Both state that devaluations have a bigger impact on the goods market the smaller the country; the difference comes from the impact on inflation: in our model, devaluation impinges more on prices in the smaller country whereas inflation impacts are the same in Martin's whatever the degree of openness. We do think that this peculiarity makes Martin's model less realistic than ours: PPP does not hold empirically since a devaluating country does not face an inflation whose magnitude is equivalent to that of the exchange rate variation; furthermore, devaluation is more inflationary in a small open economy than in a larger and more closed country.

Hence, the Euro ought to be more unstable than the past European currencies. Our present approach has nevertheless at least two shortcomings[8]. On the one hand, we ignore the reaction of the rest of the world: it is however substantial enough to change results radically. This is all the more true as far as a large country is concerned: it cannot use its interest rate without impinging on the rest of the world. On the other hand, the nature of the shocks hitting the EU has not been precised: a common shock has not the same consequences in terms of economic policy or exchange rate variability as an idiosyncratic shock. We have to tackle these two shortcomings; here is the reason for the building of a three-country model for the USA, Germany and France.

Before turning to this issue, we shall consider two other cases in our preliminary model. First, we show the macroeconomic influence of ECB's independence. Second, we study the impact of the Stability Pact.

[8] A more fundamental criticism would say that the sources of the exchange rate volatility in our first model are due essentially to the reactions of monetary policies to real shocks. This model does not discuss the influence of the size effect on the occurrence of speculative shocks or shocks caused by the modifications in the orientation of economic policies.

ECB's independence

EMU cannot be characterised by its size only. ECB's independence as well as the Stability Pact are factors involving new kinds of policy's reactions. As a first step, suppose that the ECB and European governments act freely and independently; suppose further that ECB and the government have different targets: after an inflation shock, the ECB wants to reduce it faster than governments. This situation could end in a conflict between monetary and fiscal policies; interest rates and public deficit would be high and the Euro would be overvalued (see Capoen, Sterdyniak and Villa (1994)). ECB's independence should then provoke Euro's fluctuations.

5. Supply shock: w = 1 %

Large country n = 0,1		
	Centralised policies	ECB's independence
g	0.425	1.291
r	1.363	3.427
y	– 0.423	– 0.361
q	0.425	0.476
b	– 0.296	– 0.614
s	– 1.363	– 3.427
L	1.336	1.726
L_G	0.889	1.489
L_M	1.783	1.943

Loss functions are : $L_M = y^2 + \alpha_M q^2 + \beta b^2$ avec $\alpha_M = 3$

$L_G = y^2 + \alpha_G q^2 + \beta b^2$ avec $\alpha_G = 1$

These results are clarified in our model. We take the case of a large country which suffers from a supply shock. In table 5, we present the situation in which economic policy is being centralised (fiscal and monetary authorities minimise the same loss function - equation (6)), and compare it with that of ECB's independence. In the latter case, we assume that the ECB is more reluctant to inflation than governments. The inflation shock entails a conflict between the monetary authority, which increases the interest rate to curb inflation, and governments which raise public deficits to sustain the activity level. *Ex post*, the exchange rate appreciates much and the trade balance shows a large deficit. All policymakers incur more substantial losses than in the centralised case: they would rather bargain a decrease in the interest rate for a lesser public deficit; anyway, none can improve its situation without co-operation or centralisation. If these conditions cannot be met, EMU should lead to higher volatility for the Euro.

The Stability Pact

The Stability Pact may limit the use of fiscal policy. If this happens, monetary policy will be exclusively responsible for macroeconomic stabilisation. We have already shown that a negative private demand shock cannot be stabilised in an optimal way if interest and exchange rates are fixed and fiscal policy is restricted (see table 2). An active monetary policy is thus needed: it provokes a decrease in the exchange rate. *In fine*, stabilisation is worse than with a fiscal policy, since production falls and inflation soars.

A similar result arises after an increase in the foreign interest rate or a speculative shock (see table 6): to restore output and inflation back to their initial levels (what we call optimal stabilisation), the internal interest rate has to be raised so that the exchange rate remains constant, and public deficit has to rise in order to compensate for the output effects due to the higher interest rate. Without fiscal policy, the increase in the internal interest rate will be weaker and the exchange rate tends to depreciate: inflation goes up. In these two cases, the Stability Pact gives rise to additional Euro's volatility.

6. Increase in the foreign interest rate: r = 1%*

	Large country n = 0,1		
	Initial shock	Use of r	Use of g and r
g	0	0	0.25
r	0	0.467	1
y	0.235	0.058	0
q	0.153	0.040	0
b	0.118	0.088	0
s	1	0.533	0
L	0.144	0.030	0

However, results are reversed after supply shocks (see table 3): the optimal strategy consists in increasing the interest rate, thus overvaluing the exchange rate, to curb inflation. If restrictions on fiscal policy are imposed, monetary policy will be slowed down by its negative impact on demand. On the other hand, if fiscal policy is positive while monetary policy is restrictive, large variations in the interest rate and then in the exchange rate occur. The degree of freedom of fiscal policy gives new opportunities to monetary policy which can then be used more toughly: this permits to reach a lower inflation rate. Trade deficit nonetheless falls more heavily. As a conclusion, it is straightforward that limiting fiscal deficits will reduce exchange rate fluctuations.

The Dollar and the Euro

We will here consider a three-country model with the United States on the one hand, and two European countries on the other hand, and compare three situations depending on the exchange rate regime in Europe: flexible, EMS or EMU[9]. The European countries represent France and Germany, hence a follower and a leader country in the EMS. Equations in this model are identical to the first model's (see box 1). For simplicity, we assume that the United States have a size of 200, while Germany and France have a size of 100 each. Each of the bilateral exchanges is worth 10. The US degree of openness is then equal to 10%: the USA share the case of the large country in our first model. Before any exchange rate agreement, the degree of openness of Germany and France is equal to 20% for each: they are in the case of the small country. In EMU, Europe becomes identical to the USA: the degree of openness falls to 10%; the ECB and the Fed share the same loss function, and the ECB is taking the average variations in Europe's production and inflation into account. We further assume that the ECB and European governments have the same loss function. We have already shown that Euro's volatility would be higher if the ECB was more reluctant to inflation than governments. Last, we assume that each authority minimises its loss function taking economic policy by other policymakers as given: we limit our analysis to Nash equilibria[10].

Symmetric shocks

We first study the consequences of symmetric shocks (they hit European countries in the same way). In this context, the EMS and the EMU are perfectly identical. The Bundesbank manages its interest rate according only to the German economic activity but, after a symmetric shock, the German economic situation is equal to the European average situation[11]. The Bundesbank's reaction function depends also on its perceiving the influence of its policy; in the EMS, if the Bundesbank is managed by rational bankers, they have to keep in mind that an increase in German rates will be followed by an increase in European rates so that intra-European exchange rates remain at their initial levels[12]. The impact of a rise in German interest rates on Germany is the same as a rise in European interest rates on the whole EU. Hence, as far as we are concerned with symmetric shocks, EMU's functioning will be exactly identical to that of the EMS[13].

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[9] We use a method developed by Sterdyniak and Villa (1993, a). It is assumed that European countries and the USA have flexible exchange rates one with the other.

[10] Co-operative behaviour in Europe are dealt with in Sterdyniak and Villa (1993, a) and Capoen et *al.* (1994).

[11] As an approximation, we assume that all European countries are functioning the same way.

[12] We here assume that the Bundesbank has never had as an objective an exchange rate crisis in the EMS.

[13] At least identical to the « hard EMS » between Germany, Austria, Benelux, Denmark and France.

After a negative demand shock in EMU[14], the ECB decreases its interest rate trading off between a boost in production and a positive impact on inflation and trade balance (see table 7). At stationary state, Europe undergoes a lower production level, a higher inflation and an increased trade surplus. If European countries are in flexible exchange rates, national central banks overestimate the relative influence of the interest rate on prices and trade balance. Interest rates will then be higher than in EMU to curb inflation and compensate for the trade surplus: the interest rate decreases finally less than in EMU. As a conclusion, equilibrium is better in EMU than in flexible exchange rates despite higher variations of the Euro/Dollar parity. Note however that the gap between both equilibria is very thin. This is due to the fact that in both cases, European reaction functions are almost similar: they have the same determinants with the same signs; they only differ by their coefficients values. The additional volatility is thus very weak[15].

*7. Demand shock in France and Germany**

	Initial shock		Flexible rate		EMU or EMS	
	G & F	USA	G & F	USA	G & F	USA
r	0	0	– 2.618	– 1.296	– 2.687	– 1.313
y	– 1.645	– 0.355	– 0.198	0.154	– 0.158	0.158
q	– 0.379	– 0.121	0.092	– 0.102	0.106	– 0.106
b	0.177	– 0.177	0.247	– 0.247	0.249	– 0.249
s	0		1.322		1.374	
L	3.088	0.250	0.238	0.227	0.234	0.234

* A demand shock in the USA gives symmetric results..

After a symmetric supply shock in Europe, European countries increase their interest rates, hence appreciating their currencies. In the EMU, inflation arises and production decreases. With flexible exchange rates, these countries still overestimate the relative impact of interest rates on inflation: accordingly, interest rates are raised too heavily and give rise to a larger appreciation than in the EMU. The macroeconomic equilibrium in European countries is slightly better in EMU than in flexible exchange rates: exchange rates vary less (see table 8). Let us suppose now that the supply shock occurs in the USA; the Fed raises its interest rate toughly while European countries do the same but slightly. The Euro depreciates in comparison with the Dollar. As was the case earlier, European countries increase interest rates more in flexible exchange rates than in the EMU. Hence, EMU is characterised in this context by a more substantial exchange rate volatility than in the flexible exchange

[14] We assume that the fiscal policy is not active otherwise it would perfectly stabilise the economy without any parity change.

[15] We find similar results after a speculative shock.

rate regime (recall that the Fed has raised its interest rate). Despite this higher volatility, EMU remains the better regime for European countries: losses are smaller than in the situation with European flexible exchange rates.

8. Supply shock in France and Germany; monetary policy reactions only

	Initial shock*		Flexible rate*		EMU or EMS		Flexible rate**	
	G & F	USA	G & F	USA	G & F	USA	G & F	USA
r	0	0	0.87	0.63	0.70	0.60	0.63	0.71
y	– 0.19	0.19	– 0.65	– 0.10	– 0.55	– 0.09	– 0.11	– 0.56
q	0.86	0.14	0.72	0.09	0.76	0.08	0.07	0.76
b	– 0.10	0.10	– 0.11	0.11	– 0.10	0.10	0.10	– 0.10
s	0		– 0.235		– 0.109		0.081	
L	1.549	0.104	1.519	0.060	1.501	0.051	0.053	1.507

* A supply shock in the USA gives symmetric results.

** Supply shock in the USA.

These results are not modified if governments use fiscal policy (see table 9). After a supply shock in Europe, the strong reaction of European central banks in flexible exchange rates entails a very active fiscal policy. The appreciation of European currencies *vis-à-vis* Dollar is larger than in the EMU. In this case, however, the 'impact illusion' of European policymakers is useful: they reach a better equilibrium in flexible exchange rates, where they ignore that their European partners manage the same monetary policy, than in the EMU or the EMS where they take partners' reactions into account. Tougher appreciation in this situation help to curb inflation.

9. Supply shock; monetary and fiscal reactions

	Shock in A & F				Shock in USA			
	Flexible rate		EMU		Flexible rate		EMU	
	G & F	USA	G & F	USA	G & F	USA	G & F	USA
g	0.98	0.66	0.66	0.43	0.30	0.28	0.59	0.50
r	4.10	3.42	2.88	2.39	1.56	1.58	2.63	2.53
y	– 0.47	– 0.01	– 0.45	– 0.10	– 0.02	– 0.42	– 0.02	– 0.42
q	0.73	0.16	0.75	0.14	0.10	0.80	0.08	0.82
b	– 0.19	0.19	– 0.16	0.16	0.09	– 0.09	0.10	– 0.10
s	– 0.68		– 0.50		0.02		– 0.10	
L	1.381	0.155	1.405	0.117	0.045	1.494	0.031	1.525

As a conclusion, higher Euro's volatility occurs actually after supply shocks in the USA and, more slightly, after demand shock in Europe. This result is reversed if supply shocks hit Europe.

Despite the differences in the model and loss functions, we reach the same results as Benassy et *al*. (1997). It is worth noting that Cohen (1997)[16] finds the exactly opposite result: EMU would reduce volatility after a demand shock and increase it after a supply shock. We explain this apparent contradiction in box 2. In short, Benassy et al. and us assume that prices elasticity for intra-European trade is equal to that of extra-European trade. Cohen, on the other hand, suppose with much relevance that trade among European countries rests on homogeneous products which are more sensitive to relative prices than trade with non-European partners which rests on goods that are not produced in the EU (oil, coffee...). Unfortunately, Cohen neglects the influence of interest rates on aggregate demand. If we take Cohen's assumption into account and suppose that interest rates impinge on demand, we are faced with a difficult problem: it is now impossible to dress any conclusion on the more or less volatility induced by symmetric supply and demand shocks in the EMU in comparison with flexible exchange rates. It might well be that no difference in volatility occurs; if it nonetheless happens, its direction is indeterminate.

[16] His article has the drawback that monetary policy controls the inflation rate directly, without expliciting the links between monetary policy's instruments (interest rates) and its final target (inflation). His assumption prevents him from realising that he thus explictly assumes that interest rates have no impact on demand. Furthermore, Sterdyniak and Villa (1993, b) have shown that Nash equilibrium crucially depends on the way economic control variables are described.

Box 2: An explicit solution

In order to get sure of the robustness of our results and to compare these with other specifications, we give here the explicit solutions to our simple model. We assume that the loss function depends only on production and inflation: $L = y^2 + \alpha q^2$. Policymakers use only monetary policy.

In the case of a single country in the open economy, the model becomes:

$y = u(s - w) + d$; $q = vs + w$. Hence:

(7) $s = -Ad - Bw \quad with: A = \frac{u}{u^2 + \alpha v^2} and \quad B = \frac{\alpha v - u^2}{u^2 + \alpha v^2}$

n is the degree of openness of the country; if $v = n$ and $u = n\delta + \sigma$, $A = \frac{n\delta + \sigma}{(n\delta + \sigma)^2 + \alpha n^2}$

A is always a decreasing function of n. After a demand shock, the exchange rate varies the more the smaller n, hence the larger the country. If the effect of the interest rate on domestic demand is small in comparison with the competitive effects (σ small in comparison with nδ), A is proportional to the reverse of n: the exchange rate varies like the inverse of the degree of openness.

B is positive (i.e., after an inflation shock, authorities appreciate the currency to curb inflation) if $n\alpha > (n\delta + \sigma)^2$, i.e. if policymakers are highly reluctant to inflation. This is the case in our model. B is negative if authorities prefer to stabilise production rather than inflation: they thus depreciate their currency to compensate for the loss in competitiveness.

In the case of two European countries, we will limit our analysis here to symmetric shocks and will neglect, as a first approximation, the Fed reaction. u and v are effective coefficients; u* and v* are the coefficients in flexible exchange rates as perceived by monetary authorities which do not consider that the central bank of the other European country acts as well. We obtain: $v = n$; $v^* = n + n^*$, where n is the degree of openness towards out-of-the-EU countries and n* is the degree of openness towards EU countries. Further: $u = n\delta + \sigma$; $u^* = n\delta + n^*\delta^* + \sigma$, where δ is price elasticity for extra-EU trade, and δ* is price elasticity for intra-EU trade.

In the EMU, reaction of the exchange rate is always given by (7).

With flexible exchange rates, it is such that:

(8) $s = -A^* d - B^* w \quad with \quad A^* = \frac{u^*}{uu^* + \alpha vv^*} \quad and \quad B^* = \frac{\alpha v^* - uu^*}{uu^* + \alpha vv^*}$

After a demand shock, the exchange rate reaction in the EMU is larger if $A > A^*$, hence, if $uv^* > u^* v$, i.e. if:

(9) $n\delta + \sigma > n\delta^*$

This inequality is at the heart of the differences of results between Benassy et *al.*'s (1997) and our model, on the one hand, and Cohen's (1997), on the other hand. Benassy et al. and us have not distinguished between intra- and extra-EU trade price elasticities; we have then assumed that $\delta = \delta^*$. Inequality (9) compulsorily holds: exchange rates fluctuate more in the EMU. Cohen states with great relevance that $\delta^* > \delta$: for example, France imports from EU countries goods that French firms also produce, but it largely imports from extra-EU countries raw materials which are not substitutable to other French productions. Unfortunately, Cohen assumes that monetary policy manages the exchange rate but not the interest rate: he *a priori* states that $\sigma = 0$. After a demand shock, it comes quite easily that the exchange rate fluctuates less in the EMU than in a flexible

regime. If the idea of Cohen according to which $\delta^* > \delta$ is introduced as well as $\sigma > 0$, both effects go in opposite directions. It is

no more possible to say that volatility is higher in the EMU or with flexible exchange rates. Volatility can be similar in both regimes.

After a supply shock, two situations should be distinguished. If $B > 0$, the exchange rate reaction in the EMU is larger if $B > B^*$, hence if $uv^* < u^* v$; this is the opposite of the previous condition. Volatility is reduced after a supply shock if it is increased after a demand shock (Benassy's and our case); it is larger after a supply shock if it is smaller after a demand shock (Cohen's model). If $B < 0$, the exchange rate reaction in the EMU is larger if $uv^* > u^* v$, hence if condition (9) holds. In this case, the variation in the exchange rate volatility after EMU's enforcement will be similar whatever the shock.

Idiosyncratic shocks

We now analyse asymmetric shocks[17]. Here, flexible exchange rates display a great advantage: each country is able to run the policy which is relevant to its economic situation. On the contrary, in the EMS, Germany imposes a monetary policy whose stringency or smoothness is just relevant to its internal economic context. In the EMU, monetary policy corresponds to the average European situation.

We first consider the case of a demand shock in France (see table 10). A positive fiscal policy by French government could stabilise the three economies completely. We will however suppose that fiscal policies are totally impeded by the Stability Pact. In flexible exchange rates, France's monetary authorities reduce their interest rate very toughly; the Bundesbank slightly; the Fed more slightly. There occurs a strong depreciation of the Franc/Dollar exchange rate ; the DM depreciates also, to a lesser extent. In the EMU, the decrease in the interest rate is intermediate between France's and Germany's in flexible exchange rates, but it is weakly superior to their average: the Euro's depreciation is consequently intermediate between France's and Germany's in flexible exchange rates. Though, loss functions in France and Germany give worse results in EMU than in a flexible exchange rates regime: both countries have to adapt to an « average » monetary policy which is relevant to none of them.

[17] Benassy et *al*. (1997) and Cohen (1997) do study anti-symmetric shocks only: a country undergoes a positive shock while the second suffers from a negative shock of the same size. We do not understand what would justify such shocks, unless German workers accept lower wages, for example, at the same time as French workers would get higher wages!

10. Demand shock in France

	Initial shock			Flexible rate*			EMU*			EMS shock in France			EMS Shock in Germany		
	F	G	USA	F	G	USA	F	G	USA	F	G	USA	F	G	USA
r	0			– 1.74	– 0.88	– 0.65	– 1.34	– 1.34	– 0.66	– 0.61	– 0.61	– 0.47	– 2.08	– 2.08	– 0.84
y	– 1.37	– 0.28	– 0.18	– 0.32	0.12	0.08	– 0.63	– 0.47	0.08	– 1.05	0.04	0.04	0.90	– 0.20	0.12
q	– 0.29	– 0.09	– 0.06	0.14	– 0.05	– 0.05	– 0.04	– 0.15	– 0.05	– 0.19	– 0.00	– 0.10	0.30	0.11	– 0.89
b	0.32	– 0.14	– 0.09	0.41	– 0.16	– 0.12	0.35	– 0.10	– 0.12	0.32	– 0.13	– 0.10	– 0.07	0.38	– 0.15
s	0			1.095	0.227		0.687	0.687		0.137	0.137		1.237	1.237	
L	2.338	0.150	0.250	0.635	0.095	0.057	0.766	0.295	0.058	1.497	0.053	0.030	1.237	0.496	0.100

* A demand shock in Germany gives symmetric results.

After an idiosyncratic shock, EMU is no more equivalent to the EMS. How does a shock impinge on the three economies when two are in the EMS? Suppose first that the shock hits France, whose monetary policy is following the Bundesbank's: the decrease in interest rates comes from the latter central bank who reacts according to the German situation; this reduction is too weak for French economy. In this case, EMS is the worst exchange rate regime for France, the best for Germany. Suppose now that Germany suffers directly from the shock: this time, the reduction in German interest rates is too large for France. Hence, if demand shocks hit only Germany (resp. France), Euro's volatility is higher (resp. weaker) in the EMU than in the EMS. If demand shocks hit both countries one after the other with the same frequency, volatility is the same: in such a case, the best exchange rate regime for France is flexible exchange rate, then EMU. EMS is the worst. The best regime for Germany is the EMS, then flexible exchange rate. EMU is the worst.

11. Trade shock in Europe

	Initial shock*	Flexible rate*	EMU*	EMS		
	F	F	F	F	G	USA
r	0	– 1.22	0	1.88	1.88	0.48
y	– 1.10	– 0.16	– 1.10	– 2.19	0.01	– 0.09
q	– 0.19	0.34	– 0.19	– 0.58	– 0.20	0.09
b	– 0.55	0.38	– 0.55	– 0.62	0.47	0.07
s	0	1.22	0	– 1.40	– 1.40	
L	2.175	0.699	2.175	6.61	0.75	0.04

* the situation in Germany is symmetric; the USA are not affected.

Last, suppose that a trade shock occurs in Europe; it takes the form of demand transfer between the two European countries: French trade deficit and German trade surplus increase (see table 11). With flexible exchange rates, the Banque de France lowers its interest rate while the Bundesbank augments his. The Franc depreciates in comparison with the Dollar while the DM appreciates. This reduces the trade gap and help to stabilise production. In the EMU, the ECB is crippled. Euro is stable, but both countries face worse situations. EMS is still the worst regime for France: as the Bundesbank increases its interest rate, the Banque de France is compelled to follow so that European currencies appreciate largely. As far as France is concerned, EMU will be preferred to the EMS; it is nonetheless worse than flexible exchange rates. EMU can reduce exchange rate volatility.

Mixed results

Should we fear that Euro's introduction increase exchange rate volatility on a world-wide basis? Our paper offers mixed results. Additional Euro's volatility occurs only in the case of demand shock or external supply shocks; it is relatively weak in both however. On the other hand, internal supply shocks cause a distinct reduction in volatility. This array of results can be inverted if intra-European trade sensitiveness to relative prices is particularly strong. In cases of common shocks in Europe, it must be noted that the additional volatility goes together with more optimal economic stabilisation. This volatility should have been moreover observed in the EMS. As for idiosyncratic shocks, the Euro is more stable that the currency of the hit country; this relative stability is reached at the expense of economic stabilisation. The ECB's independence could however lead to large swings in the Euro value after inflation shocks if monetary and fiscal policies do not share the same targets. Last, limits on fiscal policy in accordance with the Stability Pact can make more active monetary policies necessary: this is a source for increased volatility of the Euro.

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Appendix

Compared exchange rate volatility: empirical evidence

The volatility's concept can be defined and measured according to different methods[18]. We will limit our study to two indicators: first, standard deviations for variations in monthly exchange rates[19] which give information on the short-term volatility of nominal exchange rates; second, real exchange rates deviations from their average values which reflect long-lasting exchange rates misadjustments.

Since 1972, numerous exchange rate regimes have been tried in Europe; each corresponded to successive EMS steps. The exchange rate mechanism (ERM) is created in March 1979. It is reinforced in March 1983: realignments are no longer automatically accepted and they do not compensate exactly for inflation differentials. Since September 1987, EMS has been strengthened by intra-marginal intervention mechanisms for central banks, by the admission of the Lira in the narrow margins and by the new membership of Portugal, Spain and United Kingdom. The target for long-lasting pegs is explicitly declared. Since September 1992, EMS has been suffering from sand in the wheels of its functioning: speculative attacks in 1992-93, the Sterling's and Lira's exit from the ERM, and the enlargement of margins in August 1993 are highly significant. EMS has finally reinforced because of the increased credibility of the Single Currency's introduction.

An indicator for volatility

Standard deviations for monthly variations in nominal exchange rates expressed in DM (see table A1) show without any surprise a tough fall in exchange rate volatility between EMS members. Between 1974-79 and 1987-92 periods, volatility is reduced by 76% between the DM and the Franc and by almost 78% between the Lira and the DM. The admission of the Sterling in the ERM has reduced its volatility *vis-à-vis* the DM by 63%. On the contrary, exit from the EMS or introduction of larger margins bring volatility back to their seventies' levels.

[18] See IMF (1984), Artis and Taylor (1988), Bartolini and Bodnar (1996), and a recent application of ARCH methodology by Tse (1998).

[19] We will not deal with the « leptokurtic » exchange rate distribution (see Artis and Taylor (1988) or Pesaran and Robinson (1993)). In general, such a specificity disappears when monthly or quarterly exchange rates are studied.

A1. Standard deviations of monthly variations in exchange rates expressed in DM

	Japan	Greece	UK	Sweden	France	Italy
1974 :8-79 :2	2.30	1.67	2.13	1.55	1.65	2.47
1979 :3-83 :2	3.00	2.60	2.51	2.77	0.99	1.01
1983 :3-87 :8	2.07	2.50	2.35	1.16	0.75	0.81
1987 :9-92 :8	2.38	0.73	1.47	0.93	0.39	0.55
1992 :9-97 :11	2.78	1.00	2.31	2.45	0.69	2.69

Source : Eurostat (monthly data), authors' calculations.

Examination of the respective exchange rate volatility between large countries or between a large and a smaller non-EMS country gives nonetheless mixed results. Volatility of the DM/Dollar exchange rate has certainly been higher the stronger the EMS, but the deviations from the Yen-Dollar volatility are very weak and impede clear-cut conclusions (see table A2). The Sterling-Dollar parity is only slightly less volatile (out of periods where the Sterling joined the ERM) than the Dollar-DM exchange rate. On the contrary, the Swedish Crone and the Greek Drachma have benefited from a substantial fall in their respective volatility towards the DM; these reductions reached their trough during the most stable stage of the EMS. Volatility of those two currencies diverge however between 1992 and 1997: the Drachma remains relatively stable, whereas the Crone fluctuates largely in part because monetary authorities used the exchange rate actively as an economic policy's instrument.

A2. Standard deviations of monthly variations in exchange rates expressed in US$

	Germany	Japan	UK	France	Italy
1974 :8-79 :2	2.08	2.17	2.11	1.93	2.22
1979 :3-83 :2	2.84	3.25	2.61	2.96	2.60
1983 :3-87 :8	2.97	2.82	2.89	2.92	2.6 3
1987 :9-92 :8	3.00	2.75	3.02	2.86	2.71
1992 :9-97 :11	2.40	2.89	2.61	2.22	2.77

Source : Eurostat (monthly data), authors' calculations..

An indicator of misadjustment

To evaluate long-lasting deviations of the real exchange rates, we compare the evolution of nominal exchange rates and that of relative prices. The tested equations runs:

$$\log(s_{a/b}) = \alpha_0 + \alpha_1 T + \log\left(\frac{P_a}{P_b}\right)$$

where s is the nominal exchange rate between country a and country b; T is time; and P are consumer price indexes.

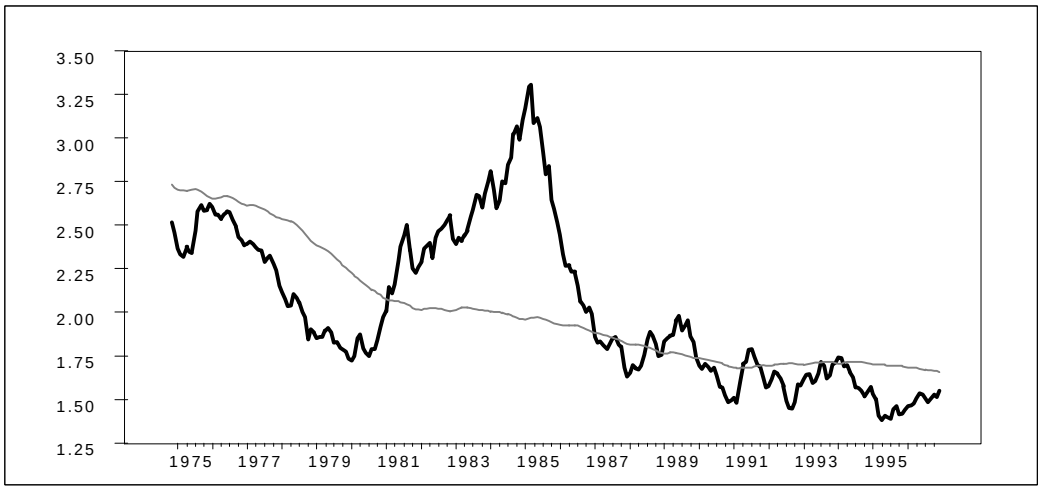
Two points are clear (see table A3 and graphics). First, EMS has reduced sharply real exchange rates deviations in comparison with the flexible exchange rates. As is shown in the comparison between the Franc-DM and Sterling-DM parities, nominal exchange rate flexibility brings in more intrinsic volatility than it compensates for prices differentials. Real exchange rate fluctuations between large countries are very sizeable and higher than those between a large and a smaller country: the DM-Dollar and Yen-Dollar parities show larger and more long-lasting misadjustment phases than the Drachma-DM or Crone-DM exchange rates. This tends to confirm the positive impact of country size on exchange rate volatility.

A3. Standard deviations of the residuals in percentage of the mean of the exchange rate

	DM/$	Yen/$	Crone/ DM	Drachma / DM	FF/DM	£/DM
σ	17.4 %	15.9 %	8.4 %	6.4 %	3.8 %	13.3 %

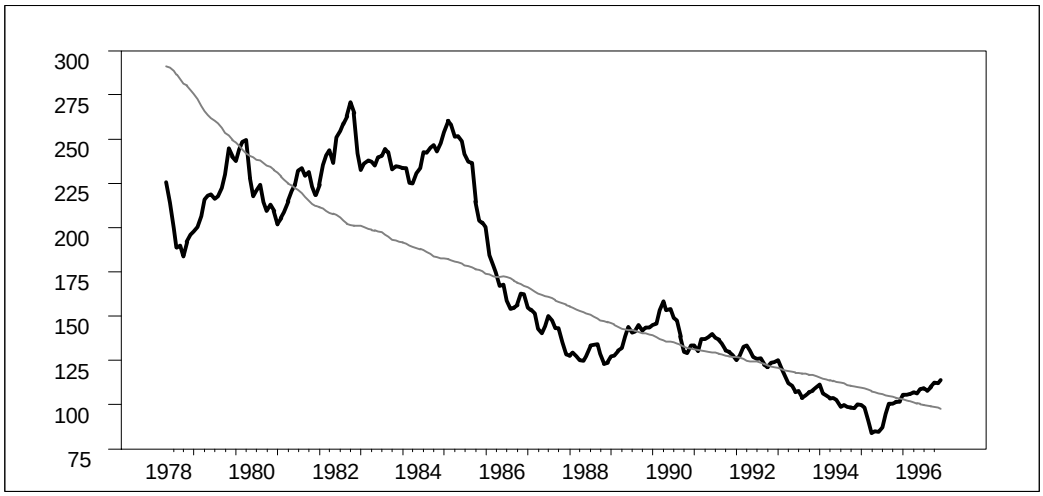
Source : authors' calculations..

G1. DM /$ exchange rate

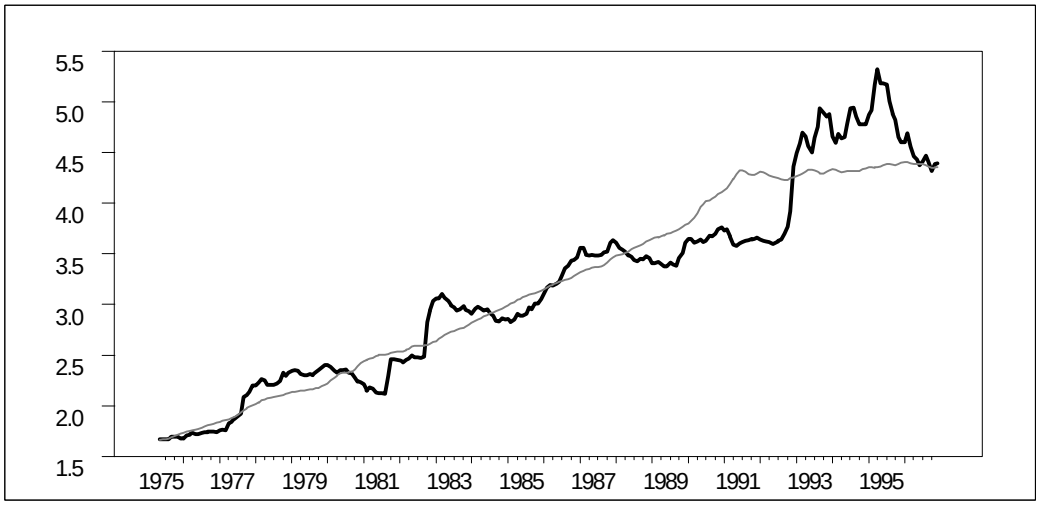


N.B.: the exchange rate is in black, its estimation in grey.

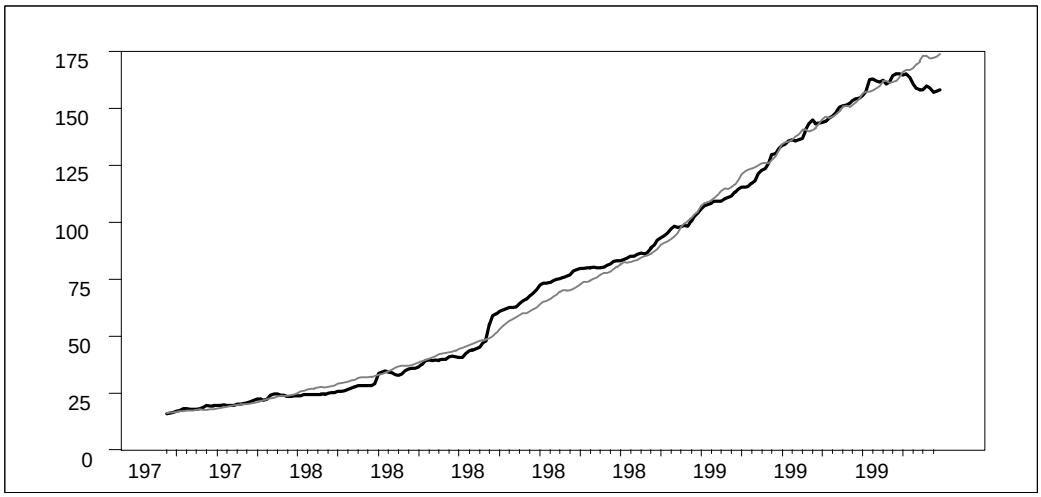
G2. Yen /$ exchange rate



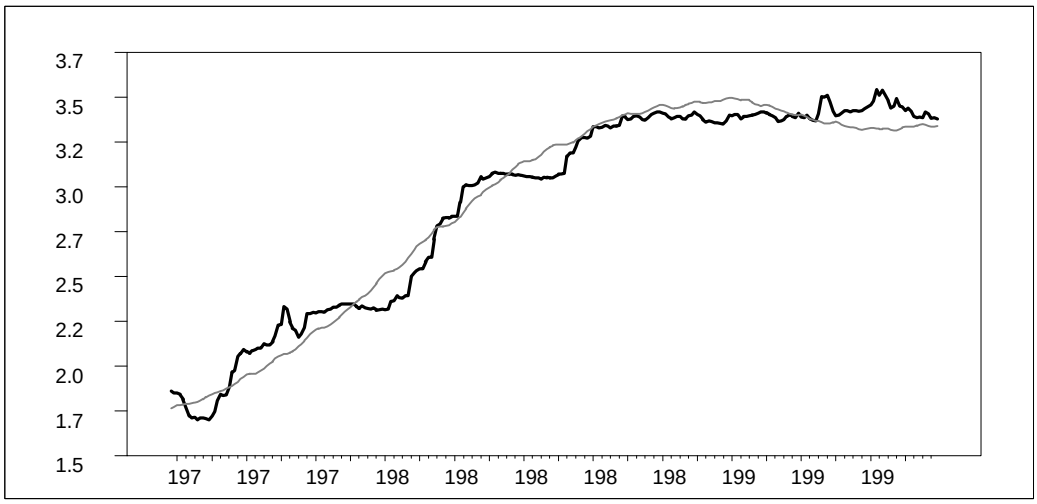
G3. Swedish crone /DM exchange rate



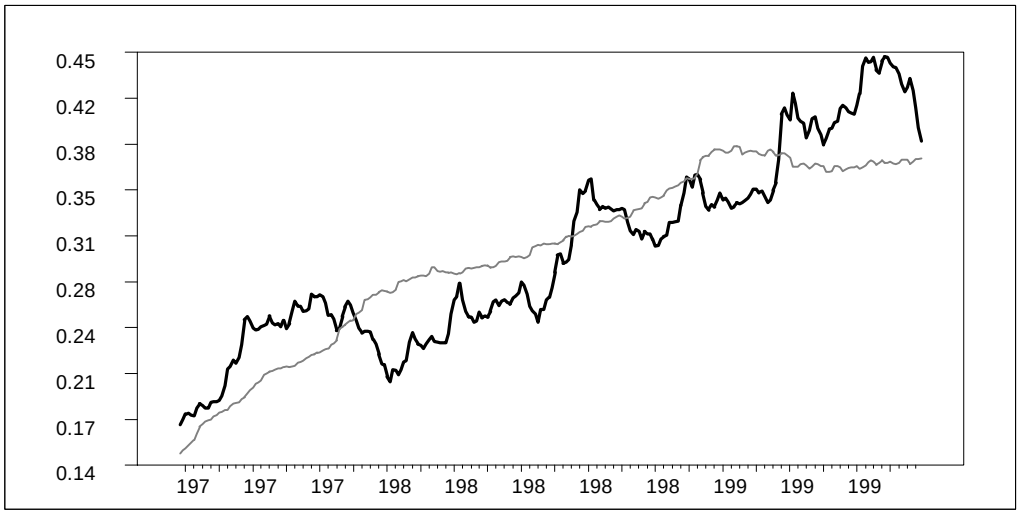
G4. Drachma/DM exchange rate



G5. FF/DM exchange rate



G6. £/DM exchange rate



10. Demand shock in France

	Initial shock			Flexible rate*			EMU*			EMS shock in France			EMS Shock in Germany		
	F	G	USA	F	G	USA	F	G	USA	F	G	USA	F	G	USA
r	0			– 1.74	– 0.88	– 0.65	– 1.34	– 1.34	– 0.66	– 0.61	– 0.61	– 0.47	– 2.08	– 2.08	– 0.84
y	– 1.37	– 0.28	– 0.18	– 0.32	0.12	0.08	– 0.63	– 0.47	0.08	– 1.05	0.04	0.04	0.90	– 0.20	0.12
q	– 0.29	– 0.09	– 0.06	0.14	– 0.05	– 0.05	– 0.04	– 0.15	– 0.05	– 0.19	– 0.00	– 0.10	0.30	0.11	– 0.89
b	0.32	– 0.14	– 0.09	0.41	– 0.16	– 0.12	0.35	– 0.10	– 0.12	0.32	– 0.13	– 0.10	– 0.07	0.38	– 0.15
s	0			1.095	0.227		0.687	0.687		0.137	0.137		1.237	1.237	
L	2.338	0.150	0.250	0.635	0.095	0.057	0.766	0.295	0.058	1.497	0.053	0.030	1.237	0.496	0.100

* A demand shock in Germany gives symmetric results.