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Euro Exchange Rates: What Can Be Expected in Terms of Volatility?

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Euro exchange rates: what can be expected in terms of volatility?

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Abstract

This paper discusses some of the issues related to the determination of the future behavior of euro exchange rates. It considers the impact of European-wide productivity and velocity disturbances on 'portfolio' diversification in Europe, under a single currency. The new currency may be less volatile than the pre-existing European currencies given that the aggregate GDP growth may be more stable and more correlated with GDP growth in the US and Japan. However, although productivity trends are not likely to change dramatically, the behavior of velocity can change substantially, during or after the change in regime. The extent to which this will be relevant will depend on the policy choices of the ECB, since there are some policy rules, such as nominal income targeting, more appropriate than others for insulating the economy from velocity disturbances.

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1 Introduction

A number of different studies have analyzed the issue of the volatility of the euro, the newly born European single currency. In the short term it is likely that portfolio adjustments will bring some instability to the system. However, another important question is whether, in the longer term, euro exchange rates will prove more or less volatile than the exchange rates of the pre-existing European currencies. To answer this question Martin (1997) builds an argument on the basis that the EMU area will be larger and less open than any individual member state, and concludes that the bigger the Union, the more stable the euro will be. By investigating the relationship between 'size' and volatility, Martin finds a hump-shaped relationship between exchange rate volatility and country size. The reason is that very large countries, which are relatively less open, have fewer incentives to use exchange rate policy strategically to stabilize the economy.

Contradicting this argument, however, both Bénassy-Quéré, Mojon and Pisani-Ferry(1997) and Cohen(1997) raise, in their theoretical models, the possibility that a policy of benign neglect may be the cause of a rise in exchange rate instability in Europe, after EMU. Masson and Turtelboom (1997), on the other hand, point to the fact that a benign neglect attitude on the part of the European monetary authority may not be possible. They argue that the uncertainties that will be faced by the European Central Bank (ECB) are likely to force the latter to adopt discretionary policies, relying on various economic indicators, one of which may be the market value of the euro, an indicator that is highly visible to the public. In addition to this argument, it can also be added that pressures from member states for exchange rate stability measures may also arise, if their competitiveness starts eroding. On several occasions throughout history, large and persistent changes in exchange rates have been accompanied by strong political pressures for protectionism in countries whose competitive position has been negatively affected (McKinnon

(1996)).[1] With policy coordination between the ECB and the FED, Masson and Turtelboom (1997) estimate that a policy towards exchange rate stability will not lead to significant changes in inflation variability. However, without such coordination, increased volatility against the dollar may put pressure on the ECB to intervene alone in the foreign exchange market, possibly hampering its credibility for fighting inflation. This possibility makes it important to understand under what circumstances the euro can bring more volatility into the international monetary system.

All the euro volatility studies mentioned above focus mainly on how the responsiveness of the exchange rate to shocks may change after its introduction, paying little attention on the occurrence of the shocks themselves. Including more idiosyncratic economies in the monetary union will be similar to diversifying a portfolio and will thus diminish the specific risk associated with the economy that issues the new currency. Volatility may diminish, because Euroland's business cycle will be less volatile and more correlated with the cycles in the other major economies. Thus a decline in exchange rate volatility may not be attributed to the ECB's actions per se. In fact, the ECB should take this aspect into consideration when defining its policies, since some monetary policy choices may be more appropriate than others for insulating the economy from destabilizing EU-wide disturbances.

This paper considers the impact of European-wide productivity and velocity disturbances on 'portfolio diversification' in Europe, under a single currency. Two other recent studies that pay more attention to the behavior of Eurozone disturbances are Ricci and Isard (1998) and Bénassy-Quéré and Mojon (1998). The first study investigates the effects of monetary union on exchange rate variability using a three-country, three-good,

[1] McKinnon argues that "exchange rate variability has a property that promotes a general rise of trade barriers" and is responsible for the increased use of quotas and other market-sharing schemes since the mid 1970's. Recent contributions showing that currency instability can have negative effects on competitiveness include Dixit(1989) and Krugman(1989a,1989b). In these papers, uncertainty is costly because it leads to delays in "real changes in the world economy that should be met by investment and disinvestment" (Krugman (1989b), p.69).

factor-specific model of trade with wage rigidity. It shows that the relative variability of the euro exchange rates may depend on the relative sizes and specialization patterns of EMU countries and the relative importance of different shocks. The study developed in the present paper, however, tries to take into account all the different shocks simultaneously and to consider the possibility of a decreased pattern of specialization in Europe, or, at least of more business cycle correlation.

The second study, by Bénassy-Quéré and Mojon (1998), is an empirical analysis where stochastic simulations are performed on a simple three country macroeconomic model of the United States, Germany and France, in order to compare the variability of various macroeconomic variables, including the transatlantic exchange rates. Their simulations show that EMU could reduce the variability of the transatlantic exchange rate, but in their study the asymmetries in Europe are minimized by reducing the euro zone to Germany and France. As the authors explain, extending this analysis to other European countries would provide a more exhaustive stochastic representation of European-wide sources of shocks, but would have the drawback of impeding the interpretation of results. The analysis developed in this paper, built on a simpler model, exactly tries to investigate how volatility may depend on the membership of the currency area, simultaneously making the point that the creation of EMU does not enhance the 'size' of any existing economy but instead combines different economies with different characteristics to back a single currency. Bénassy-Quéré and Mojon (1998)'s results are also very much dependent on the monetary policy reaction functions chosen for Europe and the US, while the present study tries to control for two different policy rules.

The model used in this paper is based on that of Canzoneri and Dellas (1995). The latter is a Cash-in-Advance model, where consumers are share-holders and divide their income between consumption, money, bonds, and equity shares. Goods are perfect substitutes and therefore, a PPP relation and a quantity theory of money relation emerge, identifying the shocks that will affect the nominal exchange rate. In particular, if both central banks involved target nominal income, the volatility of the exchange rate between two currencies will depend on the behavior of the productivity shocks in the issuing countries. The authors explore the theoretical implications of the model for a Union comprising Germany, France, Italy and the UK. This paper's version of the model tries to address the fact that the traditional empirical tests of long-run PPP have failed to find cointegration between the nominal exchange rate and relative prices. There is some evidence that the omission of transactions costs may be the cause of the rejection of a cointegrating relation in these tests. Aizenman(1984) outlines some of the effects of transactions costs on purchasing power parity and later studies such as Davutyan and Pippenger(1990) and Michael, Nobay and Peel(1997) have tried to develop the econometric implications of those effects. Due to difficulties in the measurement of transactions costs, a 'bias' is caused by their omission in estimation of the variability of the exchange rate.

Additionally, the present study extends the empirical analysis in Canzoneri et al.(1995), by combining most EU members (all apart from Belgium, the Luxembourg, Spain and Greece)[2] in several possible 'EMUs' and by introducing a longer sample period. Using quarterly GDP data between 1974-1995, it concludes that for most countries or groups of countries membership enhances the stability of the euro against both the dollar and the yen, except for the membership of Sweden and Denmark which is found to have a positive impact on the volatility of the euro-yen exchange rate. Overall, the results obtained show that the new currency may well be less volatile than the deutschemark, which is the natural benchmark to use as the deutschemark was the European currency with the most predominant role in International Finance. This reflects the fact that aggregate Eurozone GDP growth may be more stable and more correlated with GDP growth in the US and Japan. Finally, this paper addresses the endogeneity problems relevant to these results. Although productivity trends are not likely to change quickly after the formation of EMU, other characteristics of the economy such as the velocity of money,

[2] Suitable quarterly data could not be obtained for these countries - see Appendix 2.

that may be involved in the determination of exchange rate volatilities, may be altered substantially and more quickly. As stated in the conclusions, the weight of this factor will depend on the policy choices of the ECB.

The remainder of this paper is organized in another six sections. Section two presents the model, while section three discusses the effects of output disturbances on exchange rate volatility, under nominal income targets. Section four describes the methodology for aggregating output trends in EMU and testing the effects of a country's or a group of countries' membership in the monetary union and the subsequent section presents and discusses the empirical results. In section six results are derived for the case where central banks target money growth instead of nominal income and their robustness is analyzed. Section seven concludes.

2 The Model

Consider a world economy comprised of three countries: the US, Germany and France. This will be sufficient to derive results which can easily be generalized. In this economy, each period, an infinitely lived representative consumer maximizes expected utility U_t:

$$U_t = E_t \sum_{\tau=t}^{\infty} \left[\beta^{\tau-t} u(c_\tau) \right] \tag{1}$$

where E_t is the expectations operator (consumers maximize expected utility because they are uncertain about the stream of future earnings), β is a positive discount factor and $c_\tau = \alpha_i c_{i\tau} + \alpha_j c_{j\tau} + \alpha_k c_{k\tau}$ is the "utility weighted" consumption basket of the representative consumer, which includes the consumption of goods invoiced in currency i $(c_{i\tau})$, in currency j $(c_{j\tau})$ and currency k $(c_{k\tau})$). The function $u(.)$ is continuously differentiable and strictly increasing in all arguments and the 'baskets' of goods are substitutes for one another, with marginal rates of substitution given by the ratios α_i/α_j , for all i, j , $i \neq j$. Finally, notice that subscripts denote the currencies of invoice, $i = d, g, f$; $j = d, g, f$; $k = d, g, f$, and time respectively:

$$
\begin{aligned}
d &= \text{dollar} \\
g &= \text{deutschemark} \\
f &= \text{french-franc}
\end{aligned}
$$

At the beginning of period τ consumers receive income and trade assets. After this financial exchange, they are able to buy each good j using cash, and the percentage $\eta_{j\tau}$ of period's τ nominal income invoiced in currency j.[3] The remaining portion of that income can only be used for consumption if it is converted into money in the next financial exchange. This means that, at each time τ, consumers face Cash-in-Advance constraints of the form:

$$M_{j\tau} + \eta_{j\tau} p_{j\tau} Y_{j\tau} \geq p_{j\tau} c_{j\tau} \qquad \forall_j \tag{2}$$

Here $p_{j\tau}$ is the price level of goods invoiced in currency j; $Y_{j\tau}$ is fraction of real income invoiced in currency j, over which the individual has claims; and $M_{j\tau}$ is the amount of currency j nominal cash balances held at period τ. During the financial exchange, together with cash balances, consumers can also acquire one period bonds invoiced in each currency - $B_{j\tau}, \forall_j$ - which will pay positive nominal interest $i_{j\tau}$. Cash balances and bonds invoiced in one currency are characterized by how cheap it is to make transactions in that currency's foreign exchange market. If it is relatively expensive there is a 'tax' for making purchases of assets denominated in that currency. If it is relatively cheap there is a 'liquidity premium'. Let $\psi_{j\tau}$ denote the transactions costs in the market for currency i. Then, $\dfrac{1+\psi_{j\tau}}{1+\psi_{i\tau}}$ will give the 'tax'/ 'liquidity-premium' for

[3] This feature will allow the velocity to differ from 1. It was introduced into the literature by Woodford(1991).

buying assets denominated in currency j, using wealth denominated in currency i. This provides a very simple way of introducing transactions costs linked with the liquidity characteristics of the different markets. A more detailed treatment of those can be found in Rey (1997). Given the assumptions stated above, the purchase of assets is subject to the following budget constraint, expressed in units of currency i:

$$[W_{i\tau} - E_{i\tau}]\,\Psi_{i\tau} + e_{\tau}^{ij}\,[W_{j\tau} - E_{j\tau}]\,\Psi_{j\tau} + +e_{\tau}^{ik}\,[W_{k\tau} - E_{k\tau}]\,\Psi_{k\tau} \geq 0 \quad (3)$$

where

$$\Psi_{i\tau} \equiv 1 + \psi_{i\tau} \qquad \Psi_{j\tau} \equiv 1 + \psi_{j\tau} \qquad \Psi_{k\tau} \equiv 1 + \psi_{k\tau}$$

and where e_{τ}^{ij} and e_{τ}^{ik} are the exchange rates used to convert units of currency j and units of currency k, respectively, into units of currency i. $W_{j\tau}$ stands for the wealth carried through to period $\tau's$ financial exchange and $E_{j\tau}$, for period $\tau's$ expenditure in financial assets, for all j, such that:

$$\begin{aligned}
W_{i\tau} &\equiv (M_{i\tau-1}) + p_{j\tau-1}Y_{i\tau-1} + (1 + i_{i\tau-1})B_{i\tau-1} + T_{i\tau} - p_{i\tau-1}c_{i\tau-1} \\
W_{j\tau} &\equiv (M_{j\tau-1}) + p_{j\tau-1}Y_{j\tau-1} + (1 + i_{j\tau-1})B_{j\tau-1} + T_{j\tau} - p_{j\tau-1}c_{j\tau-1} \\
W_{k\tau} &\equiv (M_{k\tau-1}) + p_{k\tau-1}Y_{k\tau-1} + (1 + i_{k\tau-1})B_{k\tau-1} + T_{k\tau} - p_{k\tau-1}c_{k\tau-1}
\end{aligned}$$

$$\begin{aligned}
E_{i\tau} &= M_{i\tau} + B_{i\tau} \\
E_{j\tau} &= M_{j\tau} + B_{j\tau} \\
E_{k\tau} &= M_{k\tau} + B_{k\tau}
\end{aligned}$$

For all j, $T_{j\tau}$ are lump sum nominal transfers granted (claimed) by the government. Since the cash-in-advance constraints (2) and the financial budget constraint (3) will be binding[4], the period t first order conditions (F.O.C.s) for the maximization of the consumer's utility subject to these two constraints take the following form:[5]

[4]Interest rates are positive and utility is increasing in all arguments and depends only on consumption.

[5]Appendix 9 shows the extensive version of the budget constraint, from which it is easier to obtain the first order conditions.

$$(M_{it}) \qquad u'(c_t) - \frac{\mu_t p_{it}(1+\psi_{it})}{\alpha_i} \leq 0$$

$$(M_{jt}) \qquad u'(c_t) - \frac{\mu_t e_t^{ij} p_{jt}(1+\psi_{jt})}{\alpha_j} \leq 0 \quad \forall j \neq i$$

$$(B_{it}) \qquad \frac{1}{(1+\mathrm{i}_{it})} - \beta E_t \left[\frac{\mu_{t+1}}{\mu_t} \frac{1+\psi_{it+1}}{1+\psi_{it}} \right] = 0$$

$$(B_{jt}) \qquad \frac{1}{(1+\mathrm{i}_{jt})} - \beta E_t \left[\frac{\mu_{t+1}}{\mu_t} \frac{e_{t+1}^{ij}}{e_t^{ij}} \frac{1+\psi_{jt+1}}{1+\psi_{jt}} \right] = 0 \quad \forall j \neq i$$

where μ_t is the shadow price associated with the budget constraint and $u'(c_t)$ denotes the derivative of $u(c_t)$ with respect to c_t.

In what regards monetary and fiscal policies, it will be assumed that each fiscal authority sets the level of the primary deficit, T_{jt}, while the independent central banks decide how much will be monetized. Government bond issues are then endogenously determined by the governments' budget constraints:

$$M_{jt}^s + B_{jt}^s = M_{jt-1}^s + B_{jt-1}^s(1+r_{jt-1}) + T_{jt} \qquad \forall_j$$

where M_{jt}^s is the money supply in currency j, whereas B_{jt}^s is the supply of bonds invoiced in currency j, for all j. In addition, in this world economy, market clearing conditions are given by:

$$\begin{aligned} M_{jt} &= M_{jt}^s \\ B_{jt} &= B_{jt}^s \\ Y_{jt} &= c_{jt} \qquad \forall_j \end{aligned} \tag{4}$$

DEFINITION:

A competitive equilibrium, where all currencies are valued, in this economy, is defined as a sequence of prices $\left\{p_{jt}, i_{jt}, e_t^{ij}\right\}_{t=0}^{\infty}$ *, and allocations* $\{c_{jt}, M_{jt}, B_{jt}\}_{t=0}^{\infty}$*, for all* i, j*, such that:* (i) *cash-in advance constraints described by equation (2) are satisfied with equality (this follows from the assumptions on the utility function and nominal interest rates);* (ii) *all F.O.C.s are satisfied with equality;* (iii) *the consumers' budget constraints (3) are satisfied with equality;* (iv) *the goverments' budget constraints are satisfied;* (v) *market clearing conditions are satisfied; and, finally,* (vi) *the transversality condition and the no-Ponzi-game condition are both satisfied.*

Notice that the fact that all F.O.C.s hold with equality (because all currencies are assumed to be valued) implies an 'augmented PPP' relationship in this equilibrium:

$$\frac{(1+\psi_{it})p_{it}}{\alpha_i} = \frac{e_t^{ij} p_{jt}(1+\psi_{jt})}{\alpha_j} \Leftrightarrow e_t^{ij} = \frac{p_{it}}{p_{jt}} \left(\frac{\alpha_j}{\alpha_i} \frac{1+\psi_{it}}{1+\psi_{jt}} \right) \tag{5}$$

There are two sources of persistent deviations from the traditional PPP relation in this expression. One is the existence of transaction costs, the other is the imperfect degree of substitutability between the goods. Denote the deviation of prices and the exchange rate i, j from PPP by Φ_t^{ij} :

$$\Phi_t^{ij} \equiv \frac{1+\psi_{it}}{1+\psi_{jt}} \frac{\alpha_j}{\alpha_i}$$

This allows for a simplified version in natural logarithms of the previous relation:

$$\ln e_t^{ij} = \ln p_{it} - \ln p_{jt} + \ln \Phi_t^{ij} \tag{6}$$

$$\text{with } \ln \Phi_t^{ij} \simeq c + (\psi_{it} - \psi_{jt}),\ c = \ln \alpha_j - \ln \alpha_i$$

Hence the variability of the deviations from PPP can be attributed to the variability of transactions costs. In addition, consider the following definition of the volatility of the exchange rate between currency i and currency j:

$$\sigma^2(e^{ij}) \equiv E_t\left[\left(\ln e^{ij}_{t+1} - E_t[\ln e^{ij}_{t+1}]\right)^2\right] \tag{7}$$

Substituting equation (6) into this definition, it is possible to describe the volatility of the exchange rate in terms of the volatility of prices and transaction costs:

$$\sigma^2(e^{ij}) = E_t\left[\ \left({}_tS(p_{it+1}) - \ {}_tS(p_{jt+1}) + \ {}_tS(\Phi^{ij}_{t+1})\right)^2\right] \tag{8}$$

where ${}_tS(x_{t+1}) \equiv (\ln x_{t+1} - \ln E_t[\ln x_{t+1}])$, for any variable x.

Given that in this equilibrium all cash-in-advance constraints represented by equation (2) hold with equality and markets clear (i.e. $c_{jt} = Y_{jt}$, $\forall j$) it is possible to identify a quantity theory of money relation in this economy, where, $\dfrac{1}{1-\eta_{jt}} = V_{jt}$ is the velocity of money j:

$$M_{jt} = p_{jt}c_{jt} - \eta_{jt}p_{jt}Y_{jt} = (1-\eta_{jt})p_{jt}Y_{jt} \tag{9}$$

For the equilibrium interest rates the expression becomes more complicated as it will depend on the covariance between inflation and the inter-temporal rate of substitution in consumption:

$$\frac{1}{(1+\mathrm{i}_{jt})} = \beta E_t\left[\frac{u'(c_{t+1})}{u'(c_t)}.\frac{p_{jt}}{p_{jt+1}}\right]$$

3 Exchange rate volatility and productivity trends

The first step will be to determine how shocks will affect this economy at time $t+1$. Following Canzoneri and Dellas(1995), the stochastic behavior of output and velocity will be described by:

$$
\begin{aligned}
Y_{jt+1} &= Y_{jt}\varepsilon_{jt+1} \quad (10)\\
V_{jt+1} &= V_{jt}\upsilon_{jt+1} \quad (11)
\end{aligned}
$$

where $\varepsilon_{jt+1}, \upsilon_{jt+1}$ are exogenous random shocks affecting output and velocity respectively, uncorrelated over time and identically distributed, such that:

$$E\left[\ln \varepsilon_{jt+1}\right] = E\left[\ln \upsilon_{jt+1}\right] = 0$$

The relevance of these assumptions will be discussed in the empirical application. The next step will be to determine how policy choices will affect the behavior of prices. As a benchmark, it will be useful to assume first that the Central Banks in all countries target nominal income. Let k_j^* be the nominal income target in country j, such that:

$$\frac{p_{jt+1}}{p_{jt}}\frac{Y_{jt+1}}{Y_{jt}} = k_j^* \quad (12)$$

Then, substituting the behavior of output given by equation (10) into the nominal income targeting rule yields the following relation between inflation and productivity shocks:

$$\frac{p_{jt+1}}{p_{jt}} = \frac{k_j^*}{\varepsilon_{jt+1}} \quad (13)$$

By writing this expression in logarithms it is possible to show that, under this policy regime, next period output shocks (and only these) translate into next period price 'surprises', defined as $\ln p_{jt+1} - E_t\left[\ln p_{jt+1}\right]$:

$$E_t\left[\ln p_{jt+1}\right] = \ln k_j^* - \ln p_{jt}$$

$$\ln p_{jt+1} - E_t\left[\ln p_{jt+1}\right] = -\ln \varepsilon_{jt+1} \quad (14)$$

This expression can now be used to express the variance of the exchange rate ij in terms of the variances and covariances of the exogenous shocks hitting economies i and j. Substituting this into equation (8) yields:

$$\sigma^2(e^{ij}) = Var_{t+1}\left[\ln \varepsilon_{jt+1} - \ln \varepsilon_{it+1}\right] + \\ +Var_{t+1}\left[\ln \Phi_t^{ij}\right] + 2Cov_{t+1}\left[(\ln \varepsilon_{jt+1} - \ln \varepsilon_{it+1}), \ln \Phi_t^{ij}\right] \quad (15)$$

It might be reasonable to expect the covariance term to be positive, since there is empirical evidence of a negative relationship between transactions costs and volume.[6] Therefore, omitting deviations from PPP from the analysis may produce a downward bias in the estimates for volatility. Denote $\widetilde{\sigma}^2(e^{ij})$ the 'biased' volatility estimate:

$$\widetilde{\sigma}^2(e^{ij}) = Var_{t+1}\left[\ln \varepsilon_{jt+1} - \ln \varepsilon_{it+1}\right] \quad (16)$$

If the bias resulting from the omission of transactions costs is approximately the same for all European currencies, it should not significantly affect the ranking of those currencies in terms of volatility. In the following sections, this 'biased' volatility estimate will be used to assess the effects of EMU on exchange rate volatility, bearing in mind its possible limitations.

4 Effects of EMU on exchange rate volatility

In this section, it is assumed that, at the beginning of period $t + 1$, European countries form a Monetary Union. European output is given by the sum of the output of each of the member countries:

[6] Hartmann (1996).

$$Y_{et+1} \equiv Y_{gt+1} + Y_{ft+1} = Y_{gt}\varepsilon_{gt+1} + Y_{ft}\varepsilon_{ft+1} = Y_{et}\varepsilon_{et+1} \tag{17}$$

where

$$\begin{gathered} \varepsilon_{et+1} = w_{gt}\varepsilon_{gt+1} + w_{ft}\varepsilon_{ft+1} \\ w_{gt} \equiv \frac{Y_{gt}}{Y_{gt} + Y_{ft}};\ w_{ft} \equiv \frac{Y_{ft}}{Y_{gt} + Y_{ft}} \end{gathered} \tag{18}$$

Omitting the effect of transactions costs, according to expression (16), the estimate for the euro-dollar exchange rate, under nominal income targeting, is given by:

$$\tilde{\sigma}^2(e^{de}) = Var_{t+1}\left[\ln\left(\frac{\varepsilon_{et+1}}{\varepsilon_{dt+1}}\right)\right] \tag{19}$$

where the superscripts and subscripts d and e denote dollar and euro respectively and where the European output shock is a function of the output shocks of each of the Eurozone economies, as defined by equation (18). Consequently, the bigger the euro area, the more composite the shock term will be. It is also easy to see that the dollar could be replaced by any other third currency, such as the yen. The estimate of the euro-yen exchange rate volatility therefore can be written as:

$$\tilde{\sigma}^2(e^{ye}) = Var_{t+1}\left[\ln\left(\frac{\varepsilon_{et+1}}{\varepsilon_{yt+1}}\right)\right]$$

To obtain some insight into whether the euro should be expected to be more or less volatile than the European currencies, Canzoneri and Dellas (1995), assuming that PPP holds, use such an estimate to analyze the volatility of the dollar-euro exchange rates for a Union comprising Germany, France, the UK and Italy. They estimate the output shocks for these countries and for the US using Solow residuals calculated by Glick and Rogoff (1993). In Canzoneri's and Dellas's model goods are invoiced in the currency of the producer, which for the empirical estimates is the second best assumption since there is no suitable data on the currency invoice of trade.[7] Their sample is 1960-1990, annual observations and their results for the standard deviations of exchange rate prediction errors are summarized in the table below:[8]

Tabel 1: Model Estimates of Exchange Rate Volatility with Solow Residuals Data

$\widetilde{\sigma}(e^{dj}) \times 100$

	$1960-1990$
Germany	2.80
France	2.95
UK	2.22
Italy	3.82
Europe	1.89

Canzoneri and Dellas (1995)

These results suggest that the dollar-euro exchange rates should not be expected to be more volatile than the deutschemark, or any of the other currencies issued by the countries included in the analysis . These results do not have to correspond to real data, since, apart from the bias identified earlier, corresponding to the omission of transactions costs, these are the predictions of a model built under the assumption that all central banks target nominal income. It is interesting, nevertheless, to compare them with the standard deviations of log-changes of dollar exchange rates to see how they mimic, at least, the ranking of volatilities:[9]

[7] The ECU Institute produces some statistics on the percentage of exports invoiced in the producers currency, but this type of data is not detailed enough to be used in this kind of exercise. The data, however corroborate the idea that the assumption that exports are invoiced in the producers currency is a second best assumption (ECU Institute, 1995).

[8] Estimated regressions and the covariance matrix are reported in Appendix 1.

[9] The volatility measure reported here is the standard deviation of the changes in the logarithm of annual dollar exchange rates measured as the average of the quaterly data reported by OECD.

Table 2: Standard Deviations of Log-Changes of Dollar Exchange Rates

$\sigma(e^{dj}) \times 100$

	$60-90$	$60-73$	$74-90$
Germany	9.80	5.40	12.40
France	10.60	4.95	13.57
UK	8.50	3.95	11.12
Italy	10.50	1.67	13.66
Europe	–	–	–

OECD data for nominal exchange rates

We can verify that the ranking of the volatilities for the period 1960-1990 is similar, except for Italy. However, one of the assumptions of the model is a floating exchange rate regime. In fact, for the post-Bretton Woods period the ranking of the model becomes compatible with the true ranking. Nevertheless, it may be preferable to estimate productivity trends with data only referring to this period. Unfortunately, with the same data-set, estimations are limited to 17 observations. A second drawback of the data-set used by Canzoneri and Dellas (1995) for this analysis is the fact that it can only allow for a test on the effects of adding the UK and Italy as extra EMU members, while it should be interesting to analyze the effects of adding also the remaining EU countries, in particular those countries in the 'periphery'. However, Solow Residuals databases are only available for a very restricted sample of countries, because reliable data to construct them is difficult to obtain. Going back to the theoretical model, it seems plausible to extract the innovations from output data directly.[10] GDP data, being available in quarterly observations also allows us to extend the length of the time series.

[10]If shocks to output are mainly driven by productivity shocks (Solow residual shocks) the results derived from the two datasets should be compatible.

In order to analyze how GDP data compares with the data used in Canzoneri et al (1995) the same exercise was undertaken using the new data set for the same countries.[11] The results obtained are summarized in Table 3:[12]

Table 3: Model Estimates of Exchange Rate Volatility with GDP Data

$\widetilde{\sigma}(e_t^{dj}) \times 100$

	$1960 - 1990$
Germany	2.14
France	2.23
UK	1.95
Italy	2.58
Europe	1.90

Estimations based on the OECD data for GDP

Although the absolute values differ, the new ranking based on GDP data is similar to that reported in *Table 1.* For this reason we will accept the GDP data to be compatible with their data. The advantage of using GDP is that it is available for all EU countries, for the US and for Japan, for a relatively long period.

Using this GDP data will allow us to test the effects of the membership of particular countries or groups of countries on the instability of the euro-dollar exchange rate. To address the problems stated before, the analysis will be undertaken using quarterly data from 1974 to 1995, for the US, and most EU members. The inclusion of Japanese data in the data-set will also allow us to make predictions for the euro-yen exchange rate.

[11] Appendix 2 contains a description of the series.

[12] Regression estimates and the covariance matrix are shown in Appendix 3.

All estimates presented above omit the presence of transactions costs and incur the bias referred in the end of the last section. This omission, however, will still be necessary because the data needed to proxy these costs is not available.[13] Data on bid-ask spreads, could provide a proxy for transactions costs in the foreign exchange market, although there is no consensus on whether this is an appropriate proxy, but there are problems with the datasets available. Datastream and other commercial databases take just one particular quote of a single bank per day or the average of three or four banks at close of business. By comparing this number with the number of Reuters' quotes during April that is reported by Hartman(1997) one can have an idea of how imprecise these data are.[14] The latter uses more reliable data adding information from various sources, but this data set is a short panel with only two years. The longest accurate time series data appears in Hartman(1996), but is just available for bid-ask spreads in dollar-yen transactions (between 1986 and 1995).[15]

[13]Another way to overcome the problem could be to model deviations from PPP directly. However they may include other phenomena apart from transactions costs, such as measurement errors. Michael, Nobay and Peel(1990) show that the behaviour of deviations from PPP can be well described by an exponential smooth transition autoregressive (ESTAR) model. Fitting this process it is possible to extract the i.i.d. innovations in the deviations from PPP.

[14]Table 1, page 34.

[15]Portes and Rey (1998) estimate the volumes of trade in each currency and use Hartmann (1997)'s estimates for the elasticity of transactions costs with respect to forex volumes (-0.003), in order to obtain the 'expected' levels of euro transactions costs under different scenarios. This indirect approach may be appropriate to estimate the expected levels but cannot give information on the variability.

5 Euro Exchange Rate Volatility and EMU composition

In order to test how euro exchange rate volatility depends on the composition of EMU, several '*monetary unions*' were constructed: the 'Core', formed by Germany, France, Austria and the Netherlands (Belgium and Luxembourg excluded); the 'Core&ita', where Italy was added to the previous list of countries; the 'Eurozone', which includes the countries that have joined the single currency in the first stage, except for Belgium, Luxembourg and Spain; the 'Euro&uk', which results from adding the UK to the 'Eurozone'; and, finally, the 'Euro&outs', formed by all the countries included in the 'Eurozone' group plus the UK, Denmark and Sweeden (Greece excluded). As far as Belgium, Luxembourg, Greece and Spain are concerned, the data for these countries do not seem comparable with the data for the other countries, in terms of "frequency". In some of these cases the data may have been interpolated from annual observations and do not seem appropriate for extracting quarterly shocks. For these reasons, those countries were excluded from the analysis.

European shocks for these different '*monetary unions*', were constructed, on the basis of historical GDP trends, following equation (18), which gives the aggregate shock as a weighted combination of the individual member countries' shocks. The latter were estimated by fitting independent AR processes to the GDP series of each participating country, according to the assumptions of equation (10).

Allowing for the fact that German data after unification incorporates the data from East Germany, the statistical model assumed for output in section 4 seems to mimic the behavior of the data fairly well, except for the periods following both oil shocks in a number of countries and for the period corresponding to the steep 1978 recession in Austria and for the 'Irish boom' after 1994.[16] Estimations are reported in Appendix 4. The variances and covariances of the error terms obtained

[16]Details are given in Appendix 4.

imply the following results for the euro-dollar/ euro-yen exchange rate volatilities:

Table 4 : Model Estimates of the volatility of dollar and yen exchange rates against the German currency and hypothetical 'EMU' currencies

$\widetilde{\sigma}(e_t^{ie}) \times 100$

	dollar	yen
Germany	1.001	0.860
Core	0.931	0.745
Core&ita	0.914	0.711
Eurozone	0.910	0.705
Euro&uk	0.885	0.698
Euro&outs	0.872	0.704

Estimations based on OECD data for GDP (1974-1995)

The results suggest that the euro exchange rates against the two other major international currencies should be expected to be less volatile compared with the earlier deutschemark exchange rate. The deutschemark here is used as a benchmark because it is the European currency with a most prominent role in International Finance. The EMU that delivers the highest stability against the dollar is a monetary union formed by all the countries in the sample. In particular, the UK's opt-out clause seems to have an opportunity cost in terms of euro exchange rate stability. The decrease of volatility in the case of the UK can be easily explained by a high covariance with the US, associated with its high GDP weight.[17] In fact, adding the UK reduces the variance of European-wide disturbances and enhances their covariance with US shocks. In what concerns the volatility of the euro-yen exchange rate, the membership of Sweden

[17] Covariances are reported in Appendix 4.

and Denmark shows a positive impact on volatility, mainly due to the negative covariance of these countries' GDP with that of Japan.[18]

To verify whether the numbers reported above are statistically different from each other, a statistical test was carried out. This was constructed on the basis of the tests proposed by Diebold and Mariano(1995) for comparing forecast errors. For a loss function such as the square of the forecast errors, the difference between two loss series $(\varepsilon_{it}^2 - \varepsilon_{jt}^2)$ has an asymptotically normal distribution. Therefore, the large sample $N(0,1)$ statistic for testing the null hypothesis that the error series are different is $S = \sum(\varepsilon_{it}^2 - \varepsilon_{jt}^2)/(T\sigma)$, where σ is the standard deviation of the difference of the losses. To test whether the disturbances found for the different 'EMUs' are statistically different, the series $(\varepsilon_{it}^2 - \varepsilon_{jt}^2)$ were regressed on a constant. Notice that the $t-test$ for the hypothesis that the constant is equal to zero corresponds to S. The tests undertaken are reported in Appendix 5 and imply that most of the values in the previous table are considered satistically different from each other.[19]

Overall, most results seem to corroborate Martin(1997)'s conclusion that the larger the monetary union, the more stable it must be. However, in this case, it is the particular characteristics of productivity trends that account for this finding, and not the size in itself. In fact, adding Denmark and Sweden to the group of 'Euro&uk', enhances the volatility of the euro-yen exchange rate due to the negative covariance between the output shocks of these countries with the Japanese output shocks. EMU does not simply enlarge any existing economy, it instead applies a common monetary policy to different economies with their own specific features.

[18] These negative covariances appear even if no dummies are included in the regressions.

[19] According to this test, however, the membership of the uk is not statistically significant. It should be noted though that this test must be considered with reservation because the tests for its normality are rejected.

6 Changes in Velocity

The ranking reported above may be subject to endogeneity problems. Although productivity trends should not be expected to change significantly with the monetary Union, velocity trends may change dramatically. This is an important issue, specially if the ECB does not target nominal income, but instead targets money growth:

$$\frac{M_{t+1}}{M_t} = \pi_j^* \tag{20}$$

Substituting the monetary policy rule (20) into the velocity of money relation yields the following behavior for inflation:

$$\frac{p_{t+1}}{p_t} = \pi_j^* \frac{\upsilon_{t+1}}{\varepsilon_{t+1}} \tag{21}$$

In this case velocity shocks are important for the analysis. In particular, substituting the logarithm of this policy function into equation (8) and ignoring again the effect of transactions costs[20], the expression for the estimated volatility of the exchange rate will now take the following form, for all i, j:

$$\tilde{\sigma}^2(e_{t+1}^{ij}) = Var_{t+1}\left[\ln\left(\frac{\varepsilon_{jt+1}/\upsilon_{jt+1}}{\varepsilon_{it+1}/\upsilon_{it+1}}\right)\right] \tag{22}$$

In order to find out how the inclusion of velocity shocks in the analysis may affect the results, it is important to define European velocity, in terms of the data from the individual countries. European velocity could be defined as a weighted average of the velocities observed in each member country and it seems reasonable to assume that the weights will

[20]The bias from ignoring transactions costs in this section will be essencially the same as the one described before, provided that shocks in transaction costs are not correlated with shocks in velocity.

correspond to the relative size of each member state.[21] Taking w_{dt} and w_{ft} defined in equation (18) it will be assumed that:[22]

$$V_{et+1} \equiv w_{dt}V_{dt+1}+w_{ft}V_{ft+1} = V_{et}v_{et+1} \tag{23}$$

where

$$v_{et+1} = \frac{w_{dt}V_{dt}}{w_{dt}V_{dt} + w_{ft}V_{ft}}v_{dt+1}+\frac{w_{ft}V_{ft}}{w_{dt}V_{dt} + w_{ft}V_{ft}}v_{ft+1} \tag{24}$$

By allowing for velocity shocks and repeating the exercise of the previous section, it is possible to verify that conclusions remain unchanged even when velocity trends are taken into consideration.[23] European velocity shocks for these different '*monetary unions*', were constructed following equation (24), which gives the aggregate velocity shock as a weighted combination of member countries' velocity disturbances. The later were estimated by fitting independent AR processes to the velocity series of each participating country, according to the assumptions of equation (11).

The simple AR1 processes assumed seem to describe the data reasonably well except in the case of the US, Finland and the UK. In the case of both Finland and the UK this can be attributed to redefinitions of the Money aggregate that caused structural breaks in the M1 velocity series in 1980:I and 1987:I respectively. As for the US, a simple AR1 process cannot explain the periods of 'loose' monetary policy: 1985,1986,

[21] This assumption is different from what is assumed in Canzoneri and Dellas(1995), where the velocities in Europe are assumed to be the sum of the velocities in each member state. We consider that it is nessessary to weight velocities by size to make the new aggregate consistent with a velocity of money equation for Europe.

[22] Alternatively, European velocity could be constructed directly from the country's cash-in-advance constraints. This would imply that the weights should be the amount of cash balances in each economy, which could be proxied by today's cash balances converted into euros with the euro convertion rates.

[23] Sweden was excluded from this analysis since suitable M1 data were not available for this country.

1990, 1991, 1992 (OECD Economic Surveys, US, 1987/1988, 1993). Taking into account these observations, three different dummies were used to correct for the breaks in these series. Estimation results are reported in Appendix 7, while the data is described in Appendix 6. The impact of velocity shocks on the estimated euro exchange rate volatility of the several 'EMUs' was calculated by substituting the estimated errors in equation (22). The results are summarized in the next table.

Table 5: Model Estimates for the volatility of the dollar and yen exchange rates against the German currency and hypothetical 'EMU' currencies, considering also velocity shocks

$\tilde{\sigma}^2(e_t^{ie}) \times 100$

	dollar	yen
Germany	2.141	2.961
Core	1.630	2.659
Core&ita	1.532	2.658
Eurozone	1.515	2.624
Euro&uk	1.486	2.582
Euro&outs	1.506	2.583

Estimations based on OECD data for GDP and M1 (1974-1995)

The ranking of the volatilities of deutschemark and the different euro-dollar exchange rates remains the same, except for the group named 'Euro&outs' (the membership of Denmark shows a positive impact on the euro dollar volatility under Money target). Monetary union and, in particular, a large monetary union between European countries seems to increase stability relatively to the deutschemark. These results may be related to the findings that a European-wide money demand function appears to be more stable than national demand functions. The reason for these empirical findings has been attributed to the internalization of currency substitution effects between European currencies, through aggregation. Errors in domestic money demand appear to be negatively correlated due to their origin in currency substitution, whilst aggregation to a higher level internalizes such shocks.

A survey of the literature on area-wide money demand estimation can be found in Artis (1996). It describes the main contributions in this area and shows how the several estimated coefficients presented are reasonably stable between studies and time periods, with correct 'signs' and plausible values and how stable cointegrating equations of a relatively simple kind were found.[24] It is important to remark though that, as noticed by the author, virtually every specification described in this survey incorporates what has been labelled a 'currency substitution term' to account for substitution between European currencies and the dollar, which has proved to be very important for the good diagnostic performance of the equations. Disregarding the issue of whether the proxies chosen are actually good proxies for the phenomena that they aim to characterize, the hypothesis that currency substitution between the dollar and the euro may increase dramatically with the monetary union, makes it difficult to draw conclusions about the stability of the single money aggregate, which is likely to be as vulnerable to transatlantic currency substitution shocks as the European national currencies were among themselves.

Therefore, velocity trends may change dramatically after a monetary union is formed and the debate on whether the future European-wide money demand function maybe more or less stable than the former national money demands is still unresolved. However, this paper suggests that, ultimately, the importance of velocity shocks for the stability of the euro will depend on the policy options of the ECB and on its ability to insulate the economy from them. Additionally, the bias related to deviations from PPP may suffer from a structural break; however, it is plausible to expect that monetary unification will reduce its importance, not only because the basket of goods produced in Europe overall can be expected to become a close substitute for the basket produced in the US,

[24] The contributions surveyed are: Bekx and Tulio (1990), Kramers and Lane (1990), Artis et al.(1993), Monticelli and Strauss-Kahn (1993), Cassard et al. (1996), Tullio et al.(1996), Monticelli (1993) and an additional contribution of the author.

but also because, in terms of transactions costs, it has been anticipated that euro assets should become as liquid as dollar or yen denominated assets, though this hypothesis needs further investigation.

7 Concluding Remarks

Previous studies that tried to argue about the outcome of monetary union in terms of exchange rate stability have paid very little attention to the behavior of the relevant disturbances at an aggregate level. This paper tries to argue that aggregation, in the case of Europe, acts like portfolio diversification. Due to the presence of asymmetric shocks between European economies, aggregation may yield an overall more stable economy. In addition, the membership of countries that have a high positive (negative) business cycle correlation with the US and Japan would also contribute to decrease (increase) the variability of the exchange rate, because they make movements in the overall European output more (less) correlated with those in the US and Japan. Since productivity trends are not likely to change significantly in any foreseeable future, if the future ECB is able to insulate the European Economy from velocity shocks, then this result is likely to hold after the formation of EMU. Velocity trends, however, should be expected to change dramatically with the introduction of the euro, specially if the latter is to become a major international currency.

Although it is likely that European velocity may be more unstable in the event of internationalization, velocity shocks in Europe may start to become more correlated with those in the US. In fact, once countries start to hold as much reserves in dollars as in euros, Balance of Payments crises in third countries will start to affect the euro as much as the dollar, leaving the euro-dollar exchange rate unaffected by the turmoil. Whether the variance or the covariance effect is the predominant one is a matter of empirical investigation to be carried out ex-post. Ex-ante one thing can be stated: if the ECB does not want at all to take the risk that the new common currency introduces long-run instability in the system, it should aim, with its policy choices and expertise, at insulating the aggregate European economy from velocity disturbances.

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Appendix 1 : Canzoneri and Dellas Estimates[25]

Table A1.1: Stochastic Processes for Productivity
Dependent variable : $\ln X_t$

	c	$\ln X_{t-1}$	SEE	R^2	DW
US	0.11 (0.10)	0.98 (0.02)	2.9%	99%	1.50
Germany	0.23 (0.06)	0.95 (0.01)	2.3%	99%	1.90
France	0.22 (0.09)	0.96 (0.008)	1.8%	99%	1.79
UK	0.05 (0.15)	0.99 (0.02)	2.8%	99%	1.34
Italy	0.18 (0.05)	0.97 (0.01)	3.5%	99%	2.46

Based on data for Solow Residuals, 1960-1990 (Glick and Rogoff 1993)

Table A1.2: Variance-Covariance Matrix of Productivity Shocks
$Cov(\varepsilon_{jt+1}, \varepsilon_{it+1}) \times 100$

	US	Ger	Fra	UK	Ita	Eur
US	0.080	0.026	0.011	0.051	0.023	–
Ger		0.051	0.022	0.026	0.030	0.034
Fra			0.030	0.023	0.018	0.023
UK				0.071	0.019	0.033
Ita					0.113	0.041
Eur						0.015

[25] Canzoneri and Dellas (1995), p.23, Tables 1 and 2.

Appendix 2 : Output and Exchange Rates Data Description

The first differences of the data constructed for the US, Japan and the eleven EU countries included in the model is shown in Figure 1, while the data for the EU countries excluded from the model (Luxembourg, Belgium, Spain and Greece) is shown in Figure 2.

Figure 1: First Differences in Real GDP Series for the US, Japan and 11 EU countries - Constructed from OECD Series.

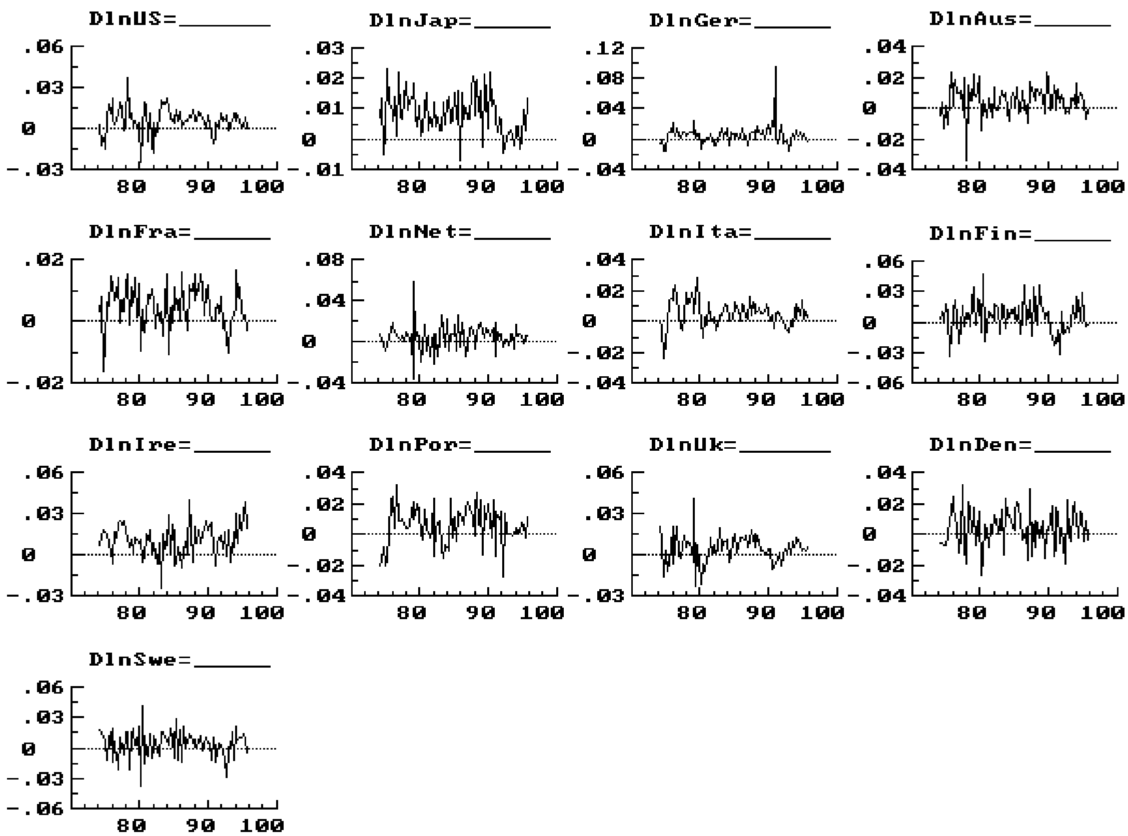
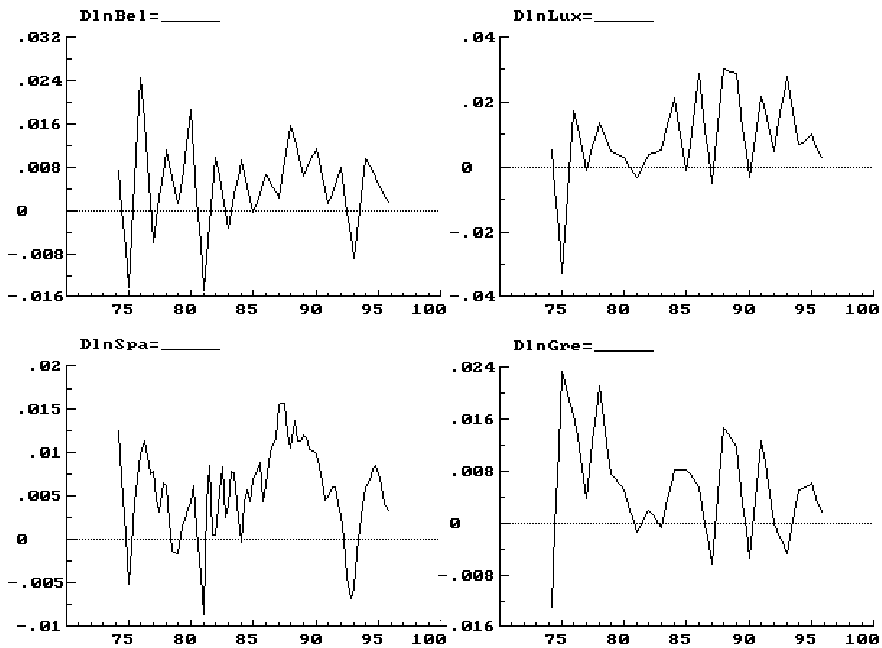


Figure 2: First Differences in Real GDP Series for Belgium, Luxembourg, Spain and Greece - Constructed from OECD Series.



The GDP data was constructed on the basis of quarterly seasonally adjusted observations of GDP nominal data denominated in the home currency. The GDP deflator with base in 1990 was used to obtain GDP at constant prices of 1990. The data was converted into dollars at the 1990 PPP conversion rates. Annual data refers to the sum of quarterly data. All data was obtained from the OECD National Accounts statistics. Data on dollar nominal exchange rates consists on dollars per national currency, as reported by the OECD.

Appendix 3 : GDP Estimates for Canzoneri et al.(1995) Sub-set of Countries and Sample Period.

Table A3.1: Stochastic Processes for Output

Dependent variable : $\ln X_t$

	c	$\ln X_{t-1}$	SEE	R^2	DW
US	0.27 (0.14)	0.98 (0.01)	1.4%	99%	1.67
Germany	0.23 (0.12)	0.97 (0.02)	1.2%	99%	1.48
France	0.36 (0.09)	0.96 (0.01)	0.4%	99%	1.49
UK	0.11 (0.15)	0.99 (0.02)	0.9%	99%	1.51
Italy	0.35 (0.08)	0.96 (0.01)	1.0%	99%	1.90

Based on the OECD data for Real GDP, 1960-1990, described in Appendix 2

Table A3.2: Variance-Covariance Matrix of Productivity Shocks

$Cov(\varepsilon_{jt+1}, \varepsilon_{it+1}) \times 100$

	US	Ger	Fra	UK	Ita	Eur
US	0.048	0.021	0.007	0.026	0.008	0.016
Ger		0.040	0.017	0.018	0.015	–
Fra			0.016	0.011	0.013	–
UK				0.042	0.011	–
Ita					0.035	–
Eur						0.020

Appendix 4 : GDP Estimates for US, Japan and 11 EU Countries (1974-95 Quarterly).

Table A4.1: Stochastic Processes for Output -Specification 1
Dependent variable : $\ln X_t$ $R^2 = 99\%$

	c	$\ln X_{t-1}$	D_{gemu}	SEE	DW	AR_{1-8}	$Norm.$
US	0.03 (0.05)	0.997 (0.006)	–	0.7%	1.32	1.84	12.87**
Jap	0.06 (0.02)	0.993 (0.003)	–	0.4%	1.88	1.14	0.33
Ger	0.01 (0.03)	0.999 (0.006)	0.09 (0.01)	0.3%	1.44	3.72**	1.52
Fra	0.04 (0.04)	0.995 (0.005)	–	0.4%	1.90	0.84	12.57**
Aus	0.01 (0.03)	0.999 (0.007)	–	0.6%	1.90	2.06*	5.70
Net	0.03 (0.04)	0.1001 (0.009)	–	0.7%	2.52	2.02	48.26**
Ita	0.08 (0.04)	0.999 (0.006)	–	0.5%	0.92	4.90**	11.70**
Fin	0.06 (0.05)	0.987 (0.010)	–	1.9%	1.81	2.02	1.62
Ire	0.01 (0.15)	1.008 (0.005)	–	1.0%	1.50	2.06*	1.04
Por	0.01 (0.03)	0.999 (0.007)	–	1.3%	1.60	2.10*	3.71
UK	0.01 (0.05)	0.999 (0.008)	–	0.8%	1.81	1.73	17.19**
Den	0.02 (0.05)	0.996 (0.010)	–	1.2%	2.06	1.21	0.85
Swe	0.10 (0.05)	0.981 (0.011)	–	1.1%	2.56	1.72	5.49

Based on the OECD data for Real GDP, 1974-1995, described in Appendix 2;
**Rejection at 10% significance; *Rejection at 5%.

The results of 'Specification 1' (Table A4.1) show that some equations are not well specified with a simple AR1. Most regressions show autocorrelation and some show non-normality. These problems are corrected in the final specification reported in Table A4.2, with the introduction several dummy variables to account for disturbances that the model cannot explain. The first are those caused by the deep recessions in Germany, France, Italy and Portugal after the first oil shock ($DIOS$). The 1974-1975 recession was sharper in these countries than generally elsewhere.. In Germany the fact was due to the sharp fall in the export volume linked with the fact that the German economy was heavily dependent on export demand, while in France it was the marked fall in private investment, in the fourth quarter of 1974, that determined the poor performance of GDP in that quarter and the next. In Italy the delayed but hash recession was caused by the combination of a slowdown in demand with tight economic policies introduced in the end of 74, including substantial tax increases and higher interest rates, introduced to refrain the expansionary trend that the economy was experiencing when the first oil shock broke. Only when the deepest recession experienced by the country since the early 1950's was already being felt did the Italian authorities shift the economic policy. As for Portugal, the post first oil shock recession was deepened by the transformation of the country's political institutions in the aftermath of the April 74 revolution, when the economy had to contend with nationalizations, collectivizations and strikes, with the loss of the colonies as a source of cheep raw material and with the return flow of Portuguese nationals from Angola and Mozambique.

Also the effects of the second oil shock in the US, Germany, France, the Netherlands, Italy and the UK cannot be explained by the simple AR1 process and had to be accounted for with a dummy variable ($DIIOS$). Additionally, another dummy variable was introduced to explain the behavior of the Austrian GDP growth in the beginning of 1978 ($Daus$). In this economy, the prior announcement of VAT increases and modifications in depreciation rules in mid 1977 to be applied in 1978, led to considerable advance purchases in the last quarters of that year. This was combined with postponement of investment spending caused by the announcement of a new Federal Investment Program in January of the same year and resulted in a very depressed GDP growth for the beginning of 1978. The shift in the trend caused by the Irish boom also had to be accounted for with dummy variables ($Dire$).[26]

Table A4.2: Stochastic Processes for Output - Final Specification
Dependent variable : $\ln X_t$ $R^2 = 99\%$

	c	$\ln X_{t-1}$	$D_{gemu/aus/ire}$	D_{IOS}	D_{IIOS}	SEE	DW
US	0.02 (0.04)	0.998 (0.005)	–	–	−0.016 (0.004)	0.6%	1.45
Jap	0.05 (0.02)	0.993 (0.003)	–	–	–	0.4%	1.88
Ger	0.02 (0.02)	0.998 (0.004)	0.09 (0.01)	−0.018 (0.004)	−0.018 (0.005)	0.4%	1.56
Aus	0.07 (0.02)	0.999 (0.006)	−0.024 (0.006)	–	–	0.6%	1.90
Fra	0.04 (0.03)	0.989 (0.005)	–	−0.019 (0.004)	−0.016 (0.006)	0.3%	1.74
Net	0.01 (0.03)	0.999 (0.007)	–	–	−0.037 (0.004)	0.7%	2.37
Ita	0.05 (0.02)	0.992 (0.004)	–	−0.018 (0.003)	−0.014 (0.003)	0.3%	1.49
Fin	0.06 (0.05)	0.988 (0.010)	–	–	–	1.9%	1.81
Ire	0.01 (0.01)	0.997 (0.005)	0.021 (0.005)	–	–	1.0%	1.57
Por	0.02 (0.02)	0.994 (0.007)	–	−0.026 (0.009)	–	1.1%	1.75
UK	0.01 (0.04)	0.999 (0.007)	–	–	−0.017 (0.007)	0.7%	1.80
Den	0.02 (0.03)	0.994 (0.010)	–	–	−0.031 (0.012)	1.1%	2.11
Swe	0.07 (0.05)	0.984 (0.012)	–	–	−0.042 (0.012)	1.2%	2.28

Based on the OECD data for Real GDP, 1974-1995, described in Appendix 2

[26] OECD Economic Surveys.

In this final specification all equations pass the 'portmanteau' autocorrelation test with 8 lags and the χ^2 normality text at the 10 percent significance level except for the German equation which satisfies the normality test at the 10 percent significance level but the autocorrelation test only at the 5 percent significance level. A dummy for the second oil shock was not significant for Japan, Austria, Finland, Ireland and Portugal.

Table A4.3: Variance-Covariance Matrix of Productivity Shocks

$Cov(\varepsilon_{jt+1}, \varepsilon_{it+1}) \times 1000$

	Var	Cov		
		Ger	Us	Jap
Ger	0.045	–	0.009	0.006
Aus	0.071	0.025	0.004	0.005
Fra	0.033	0.019	0.005	0.007
Net	0.083	0.020	0.010	0.012
Ita	0.036	0.013	0.005	0.008
Fin	0.224	0.003	0.004	0.001
Ire	0.101	0.009	0.004	0.008
Por	0.146	0.016	0.009	0.017
Uk	0.088	0.003	0.014	0.005
Den	0.132	0.016	0.030	−0.008
Swe	0.137	0.009	0.010	−0.005

$Var(US) \times 1000 = 0.074$; $Var(Jap) \times 1000 = 0.042$

Appendix 5 : Ranking Significance Tests for Estimates under Nominal Income Targeting

Significance Tests for the ranking of volatilities were constructed on the basis of the tests for ranking forecasting errors developed by Diebold and Mariano (1995). Any two volatility values were considered to be statistically different whenever the two series of 'European' output shocks that generated each of them were found to be statistically different. 'European' output shocks' series were estimated according to equation (18), using the results of the final specification reported in Appendix 4. Here mostly the significance of any two consecutive volatility values was tested for, but a test on the significance of the ranking between the volatility of the euro exchange rates of the 'Eurozone' and the 'Euro&outs' was also included. The results are reported in Table A5.1. These tests, though must be looked at with some reservation since they were found to have a higher peak around their mean of zero than a normal distribution would have.

Table A5.1: Ranking Tests (Nominal Income Targeting)
- Final Specification -

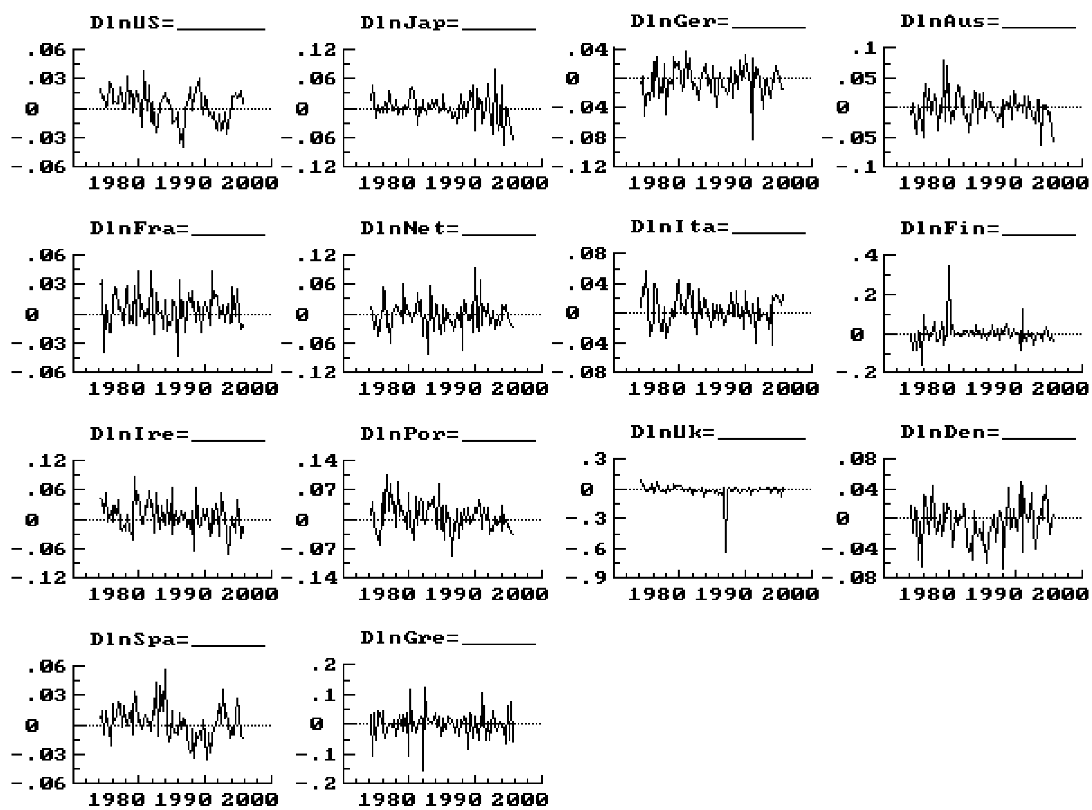
Tests	costant	t-value	DW
Germany vs Core	$1.70E-05$	3.63	1.66
Core vs Core&ita	$4.26E-06$	2.66	1.89
Core&ita vs Eurozone	$8.60E-07$	2.00	1.97
Eurozone vs Euro&uk	$1.77E-06$	1.08	1.59
Euro&uk vs Euro&outs	$1.03E-06$	2.00	2.22
Eurozone vs Euro&outs	$2.80E-06$	1.62	1.66

Results suggest that the estimates for the euro volatilities of the Core can be considered significantly different than those estimated for the deutschemark, since the t-value for the constant term is high. Similarly, adding Italy to the Core to form 'Core&ita' or adding Finland, Ireland and Portugal to the 'Core&ita' to form the 'Eurozone' seems to have a significant impact on the volatility estimates. This also applies to adding

Sweden and Denmark to the group of 'Euro&uk'. Adding the UK does not seem to have a significant impact, although, due to the non-normality of the test, rejecting any significance requires the investigation of the appropriate critical values which are likely to be lower than 2.

Appendix 6: Velocity Data Description.

Figure 3: First Differences in M1 Velocity Series for the US, Japan and Europe - Constructed from OECD Series.



The velocity data was constructed on the basis of quarterly seasonally adjusted observations for M1, obtained from the OECD database. All series were already seasonally adjusted, except for the UK. The UK money series was adjusted for seasonality with the method of average deviations from the trend, taking into account the break in 1987. The first differences of the series constructed are shown in Figure 3.

Appendix 7 : Velocity Estimates for US, Japan and 11 EU countries - 1974-1995 Quarterly Data

Table A7.1: Stochastic Processes for Velocity
Dependent variable : $\ln V_t$

	c	$\ln V_{t-1}$	D_{usa}	D_{fin}	D_{uk}	SEE	R^2	DW
US	0.17 (0.09)	0.968 (0.017)	0.197 (0.003)	–	–	1.2%	97%	1.61
Jap	0.31 (0.19)	0.930 (0.044)	–	–	–	5.3%	84%	1.77
Ger	0.08 (0.10)	0.983 (0.021)	–	–	–	0.4%	99%	1.89
Aus	0.17 (0.15)	0.965 (0.030)	–	–	–	5.2%	92%	1.69
Fra	0.07 (0.07)	0.985 (0.015)	–	–	–	2.4%	98%	2.23
Net	0.11 (0.13)	0.976 (0.029)	–	–	–	6.9%	93%	2.17
Ita	0.16 (0.09)	0.963 (0.020)	–	–	–	3.3%	96%	1.61
Fin	0.22 (0.11)	0.994 (0.029)	–	0.340 (0.040)	–	1.2%	95%	2.43
Ire	0.25 (0.09)	0.954 (0.018)	–	–	–	6.7%	97%	1.89
Por	0.17 (0.07)	0.964 (0.016)	–	–	–	9.8%	98%	1.83
UK	−0.02 (0.03)	0.998 (0.016)	–	–	−0.63 (0.03)	6.9%	98%	1.85
Den	0.06 (0.06)	0.986 (0.014)	–	–	–	5.5%	98%	1.65

Based on the OECD data for Real GDP, 1974-1995, described in Appendix 2

Appendix 8 : Ranking Significance Tests for Estimates under Money Targeting

Table A8.1: Ranking Tests (Money Targeting)
- Final Specification -

Tests	costant	t-value	DW
Germany vs Core	$2.06E-04$	3.11	1.93
Core vs Core&ita	$3.06E-05$	2.82	1.97
Core&ita vs Eurozone	$7.94E-06$	2.55	1.84
Eurozone vs Euro&uk	$-6.02E-06$	-0.28	2.18
Euro&uk vs Euro&outs	$2.59E-06$	2.80	1.92
Eurozone vs Euro&outs	$2.80E-06$	1.62	1.66

Appendix 9: The Budget Constraint

In order to solve for first order conditions, it is easier to rewrite the budget constraint:

$$[M_{i\tau-1}+\eta_{i\tau-1}p_{i\tau-1}Y_{i\tau-1}-p_{i\tau-1}c_{i\tau-1}]\,(1+\psi_{i\tau})+$$

$$+e^{ij}_{\tau-1}\,[M_{j\tau-1}+\eta_{j\tau-1}p_{j\tau-1}Y_{j\tau-1}-p_{j\tau-1}c_{j\tau-1}]\,(1+\psi_{j\tau})+$$

$$+e^{ik}_{\tau-1}\,[M_{k\tau-1}+\eta_{k\tau-1}p_{k\tau-1}Y_{k\tau-1}-p_{k\tau-1}c_{k\tau-1}]\,(1+\psi_{k\tau})+$$

$$+\left[(1+\mathrm{i}_{i\tau-1})B_{i\tau-1}+(1-\eta_{i\tau-1})p_{i\tau-1}Y_{i\tau-1}+T_{i\tau}\right](1+\psi_{i\tau})$$

$$+e^{ij}_{\tau}\left[(1+\mathrm{i}_{j\tau-1})B_{j\tau-1}+(1-\eta_{j\tau-1})p_{j\tau-1}Y_{j\tau-1}+T_{j\tau}\right](1+\psi_{j\tau})$$

$$+e^{ik}_{\tau}\left[(1+\mathrm{i}_{k\tau-1})B_{k\tau-1}+(1-\eta_{k\tau-1})p_{k\tau-1}Y_{k\tau-1}+T_{k\tau}\right](1+\psi_{k\tau})$$

$$-\left[M_{i\tau}+B_{i\tau}\right](1+\psi_{i\tau})-e^{ij}_{\tau}\left[M_{j\tau}+B_{j\tau}\right](1+\psi_{j\tau})-$$

$$-e^{ik}_{\tau}\left[M_{k\tau}+B_{k\tau}\right](1+\psi_{k\tau})\geq 0$$