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ABSTRACT

We compare monetary union to flexible exchange rates in an asymmetric, three-country model with active monetary policy. Unlike the traditional OCA literature, we find that countries with a high degree of nominal wage rigidity benefit from monetary union, specially when they join other, similarly rigid countries. Countries with relatively more flexible wages tend to be worse off in unions with countries that have more rigid wages. We examine France, Germany and the UK and find that the welfare implications of alternative monetary arrangements depend more on the degree of wage asymmetry than on other types of asymmetries (in shocks, monetary policy etc.). And that, higher degree of wage flexibility in the UK relative to France and Germany would make its participation in EMU costly.

Keywords: Monetary union, wage rigidity, asymmetry, multi-country model

JEL classification: E4, E5, F4

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1 Introduction

Several members of the European Union formed a monetary union in 1999. Others opted to remain outside. A great deal of academic and political debate has surrounded this event. It has focused both on the effects of EMU for macroeconomic stability in its participant countries and on the wisdom of remaining outside once a currency union has been formed.

This debate has taken place more or less within the traditional Mundell-Fleming model and the associated optimum currency area (OCA) literature. A key result that has emerged from this literature is that the cost of participation in monetary union increases with (see de Grauwe, 2001): a) Dissimilarities in economic structure, and in particular, in the degree of asymmetry in the shocks. b) The degree of nominal rigidities. Countries with rigid nominal wages (prices) and asymmetries may want to retain the exchange rate instrument in order to have an adjustment mechanism that could serve as a substitute for the lack of nominal price adjustment (see also Friedman's, 1953, case for flexible exchange rates).

The choice of the exchange rate regime is a special case of the more general issue of optimal monetary policy in an open economy. There is a new and fast expanding literature that uses the New Keynesian Model (NKM)to investigate the performance of alternative open economy monetary policy rules (Begigno and Benigno, 2000), the macroeconomic and welfare properties of alternative exchange rate regimes (Collard and Dellas, 2002, Devereux and Engel, 2001, Duarte, 2001, Kollmann, 2001) and the welfare implications of different degrees of international policy coordination (Canzoneri, Cumby and Diba, 2002, Clarida, Gali and Gertler, 2002, Pappa, 2001, Obstfeld and Rogoff, 2001). The message that emerges from this literature concerning the value of the exchange rate instrument is more mixed. The results depend on the currency denomination of trade, the structure (completeness) of financial markets, the type of policy rule considered and differences in size across countries.

In this paper we extend this literature in several directions. First, we evaluate alternative exchange rate systems within a multi (three) country model. This allows us to discuss the effects on the "ins" and the "outs" as well as the optimal choice of partner as a function of various types of asymmetries. The choice of a partner is implicit in the OCA literature but has not received any direct atten-

tion. A noteworthy exception is Hughes-Hallet and Hougaard Jensen, 2001, who examine the incentives to participate and/or admit members in a monetary union in relationship to the level of economic reform accomplished. Second, we examine the role of asymmetries across countries not only in the shocks (or economic size) as it is common in the existing literature but also in labor markets. And third, we use a quantitative model to evaluate the various options faced by the three largest economies in Europe, France, Germany and the UK.

Suppose that one classified France and Germany as high and the UK as low nominal wage rigidity countries[1]. There are several questions of interest. a) Are France and Germany better off –and by how much– in a currency union relative to regime of freely floating rates? b) Does the answer to this question depend on the UK's decision to participate or not? c) Does the formation of monetary union have any significant external effects on the –nonparticipant– UK (and vice versa)? d) Conditional on the existence of a currency union involving mostly countries with inflexible labor (wage) markets, is it in the best interest of the flexible economy's (the UK) to join in? e) Are countries better off when they form a union with countries that are alike (in terms of inflexibility) or with countries that are different? While most of the existing literature deals with the first question within two country models (Collard and Dellas, 2002) and much of the current political debate is focusing on whether the UK would benefit from the adoption of the Euro (question d), the list of the questions presented above suggests that this is but a small subset of empirically relevant issues that may be worth exploring.

We address these questions within a general equilibrium, three country model whose features include nominal wage rigidities[2], active monetary policy (Taylor rules), complete asset markets and a variety of shocks (supply, fiscal and monetary). Three international monetary arrangements are considered: Flexible exchange rates for all three countries, a two country monetary union with the third country pursuing a floating regime (we call this "mixed") and a catholic monetary union. Our main results can be summarized as follows:

In the benchmark case of perfect symmetry, countries are better off when they

[1]See Nickell, 1997, for some evidence on this.

[2]Other sources of nominal rigidities are possible. Our choice of wage rather than price rigidities is motivated by recent empirical work by Christiano, Eichenbaum, and Evans, 2001, that finds that the former are relatively more important.

participate in a currency union and the benefits increase with the number of participants. The gains can be significant when the degree of nominal wage rigidity is *high* but they tend to be small when rigidity is low. This contrasts with the traditional OCA analysis as well as Friedman's, 1953, case for flexible rates (namely, that they fare well when wage rigidity is high) and obtains in spite of the fact that policy is activistic. The improvement in welfare comes from three sources. Firsts, from the existence of nominal wage rather than price rigidities. Second, from the existence of important supply and monetary shocks. For fiscal shocks, flexible rates fare better (for the reasons suggested in the traditional OCA literature; see also Poole, 1970). And third, from the fact that the model uses foreign intermediate goods in domestic production. This implies that an exchange rate change that has favorable effects on the demand for domestic products has unfavorable effects on the supply side of the economy as it increases the cost of domestic production.

We also show that asymmetries in wage flexibility across countries play a more important role in the evaluation of alternative regimes than other types of asymmetries (e.g. in the shocks, monetary policy etc.). Countries with substantial wage rigidities benefit from monetary union, specially when their partners are equally rigid. Countries with *relatively* more flexible wages are better off when they stay out. When we take into account the various sources of actual asymmetries that exist in the EU, we find that a substantially greater wage flexibility in the UK relative to France and Germany would discourage it from forming a union with them. In contrast, France and Germany always benefit from forming a currency union. Whether they would also like to include the UK or not depends on the type of monetary policy rules considered.

The remainder of the paper is organized as follows. Section 1 presents the three country model. Section 2 describes the calibration. Section 3 discusses the benchmark case of perfect symmetry. Section 4 presents the main findings under wage asymmetry and section 5 the general asymmetric case.

2 The model

The three countries are modelled in a similar fashion[3] so we describe only one country, the UK (a technical appendix to this paper, available at both the EJ and our website, offers a detailed description of the other two countries).

The economy consists of a large number of identical households and firms, a fiscal authority and a monetary authority.

2.1 The household

The household maximizes expected lifetime utility:

$$E_0[\sum_{t=\infty} \beta^t U(C_t^S, h_t^S)] \tag{1}$$

where $0 < \beta < 1$ is a constant discount factor, C_t^S denotes UK consumption in period t and h_t^S is the number of hours worked by the UK representative household. $U(C_t^S, h_t^S)$ is a utility function, increasing and concave in its first argument, and decreasing and convex in its last argument. The following utility function will be used:

$$U(C_t^S, h_t^S) = \log(C_t^S) + \theta \log(1 - h_t^S) \tag{2}$$

where θ is a weight for the marginal utility of leisure.

In each and every period the UK household faces two budget constraints. The first one takes the form

$$\begin{aligned} & P_t^S C_t^S + P_t^S I_t^S + \int_\ell (\frac{\widetilde{P}_t^F}{e_t^S} B_{S,t+1}^F + \frac{e_t^G}{e_t^S} \widetilde{P}_t^G B_{S,t+1}^G + \widetilde{P}_t^S B_{S,t+1}^S) d\ell + M_{t+1}^S + P_t^S T_t^S \\ = \; & W_t^S h_t^S + z_t^S K_t^S + \Pi_t^S + \frac{B_{S,t}^F}{e_t^S} + \frac{e_t^G}{e_t^S} B_{S,t}^G + B_{S,t}^S + M_t^S + N_t^S \end{aligned} \tag{3}$$

where P_t^S denotes the price of UK consumption and investment goods, I_t^S is investment, e_t^S is the FF/BP exchange rate, e_t^G is the FF/DM rate (hence e_t^G/e_t^S

[3]Nevertheless, they may still differ in terms of size, economic structure, shocks and so on.

is the BP/DM rate), $\widetilde{P}_t^j$ is the price paid for an asset that will deliver 1 unit of country j's currency (j = F, G, S) next period if state ℓ realizes. A typical UK household owns $B_{S,t}^j$ such assets entering period t. M_t^S is the stock of money held by the UK household in period t, T_t^S is *lump-sum taxes*, W_t^S is the nominal wage, z_t^S is the rental rate for capital, K_t^S is the physical capital stock at the beginning of period t, Π_t^S are the profits of the UK firms and N_t^S is a per-capita amount of money issued by the Bank of England (BoE) and given to the households in the form of a helicopter drop.

According to the budget constraint, the households enters period t holding an amount of money equal to M_t; it receives income from its financial investments, $B_{S,t}^j$, from its labor services, from renting capital to the firms. It also receives its share of the profits distributed by the firms and its share of the money injection by the BoE. It uses these funds to buy new financial assets, to build its cash reserves, to pay taxes and to purchase goods for consumption and investment purposes.

The second budget constraint is a cash-in-advance (CIA) constraint on consumption purchases:

$$P_t^S C_t^S \leq M_t^S \tag{4}$$

Physical capital accumulates according to

$$K_{t+1}^S = \Phi(\frac{I_t^S}{K_t^S})K_t^S + (1-\delta)K_t^S \tag{5}$$

where $0 \leq \delta \leq 1$ denotes the rate of depreciation. The concave function $\Phi(.)$ captures the presence of adjustment costs to investment. It is assumed to be twice differentiable and homogenous of degree 0. Furthermore, we assume the absence of adjustment costs in the steady state: $\Phi(\gamma+\delta-1) = \gamma+\delta-1$, $\Phi'(\gamma+\delta-1) = 1$ and $\frac{\Phi''(\gamma+\delta-1)(\gamma+\delta-1)}{\Phi'(\gamma+\delta-1)} = \varphi$.

Finally, we will assume that –at least a fraction of– the nominal wages is fixed one period in advance[4] at a level that is equal to the expected labor market clearing wage. In particular, the fixed nominal wages are set using labor contracts of the form

[4]Other sources of nominal rigidities are possible. Our choice of wage rather than price rigidities is motivated by recent empirical work by Christiano, Eichenbaum, and Evans, 2001, that finds that the former are more important.

$\widetilde{W}_t = E_{t-1}W_t$

$E_{t-1}W_t$ is the expected "equilibrium"nominal wage

$0 \leq \vartheta \leq 1$ is the share of labor contracts in the economy

The households that have signed labor contracts must then supply whatever quantity of labor is demanded by the firms.

2.2 The firms

There are two types of firms, those that produce an intermediate good, Y, and those that produce a final good, Q.

The production of the intermediate good is done according to:

$$Y_t^S = a_t^S (K_t^S)^{\alpha} (\Gamma_t h_t^S)^{1-\alpha} \tag{6}$$

where K_t denotes the physical capital stock at the beginning of period t. Γ_t represents Harrod neutral, deterministic, technical progress evolving according to $\Gamma_t = \gamma \Gamma_{t-1}$. $\gamma \geq 1$ denotes the deterministic rate of growth. a_t^S is a stationary, exogenous, stochastic technology shock.[5]

The representative intermediate good firm chooses the quantity of capital and labor to lease in period t in order to maximize its current profits

$$\pi_t = P_{Yt}^S Y_t^S - W_t^S h_t^S - z_t^S K_t^S \tag{7}$$

where P_{Yt}^S is the price of the UK intermediate good.

The country specific intermediate goods are then combined to produce the final goods in the three countries.

$$Y_t^S = Y_{Ft}^S + Y_{Gt}^S + Y_{St}^S \tag{8}$$

where $Y_{j,t}^S$ denotes the amount of UK intermediate good that is used as an input to produce country j's final good in period t.

2.3 Production of the final domestic good

The production of the final good in the UK, Q_t^S, takes place according to:

[5]The stochastic properties of the technology shock will be specified later.

$$Q_t^S = [\varpi_4^{1-\rho}(Y_{S,t}^F)^\rho + \varpi_5^{1-\rho}(Y_{S,t}^G)^\rho + \varpi_6^{1-\rho}(Y_{S,t}^S)^\rho]^{\frac{1}{\rho}} \tag{9}$$

The level of production is selected in order to maximize profits:

$$\pi^S = P_t^S Q_t^S - \frac{P_{Yt}^F}{e_t^S} Y_{S,t}^F - \frac{e_t^G}{e_t^S} P_{Yt}^G Y_{S,t}^G - P_{Yt}^S Y_{S,t}^S \tag{10}$$

where ϖ_4, is the weight of the French goods in the UK final good basket, ϖ_5, is the weight of German goods in this basket and ϖ_6 denotes the weight of UK goods in the domestic (UK) basket. Recall that $Y_{F,t}^j$ is the amount of the intermediate good of country j (j = F, G, S) used in the production of the UK final good. $\frac{1}{\rho-1}$ is the elasticity of substitution between the domestic and foreign intermediate goods. This way of modelling import and export activities is called the *Armington aggregation* and implies that the imported goods have to be transformed into a domestic good, Q_t^S, before they can be consumed or used for investment. It follows that the three countries will have different price levels for their final goods, P_t^i, as these goods are not perfect substitutes.

Clearing of the UK final good market requires:

$$Q_t^S = C_t^S + I_t^S + G_t^S \tag{11}$$

where G^S is UK government expenditure.

2.4 The government

In each period the government acquires an amount G_t of the final good. The cyclical component of government expenditures ($g_t = G_t/\Gamma_t$) is exogenously determined by a stationary AR(1) process such that:

$$\log(g_t) = \rho_g \log(g_{t-1}) + (1 - \rho_g) \log(g) + \varepsilon_{gt} \tag{12}$$

with $|\rho_g| < 1$ and $\varepsilon_{gt} \rightsquigarrow \mathcal{N}(0, \sigma_g)$.

These expenditures are financed by means of lump–sum taxation

$$P_t^S G_t^S = P_t^S T_t^S \tag{13}$$

2.5 The monetary authorities

The behavior of the monetary authorities depends on the international monetary arrangement in place. Under a flexible exchange rate regime, we assume that monetary authorities pursue active monetary policy. In particular, central banks are assumed to follow a forward looking Taylor rule. For instance, in the UK this rule takes the form[6]

$$\widehat{R}_t^S = \rho_r^S \widehat{R}_{t-1}^S + (1-\rho^S)(K_y^S E_t(\widehat{Y}_{t+1}^S) + K_\Pi^S E_t(\widehat{\Pi}_{t+1}^S)) + \zeta_{r,t}^S \tag{14}$$

where R_t^S is the gross nominal interest rate, ρ_r^S denotes the degree of interest rate smoothing, $E_t(\widehat{Y}_{t+1}^S)$ is expected output (relative to target), $E_t(\widehat{\Pi}_{t+1}^S)$ is expected CPI inflation (relative to target) and $\zeta_{r,t}^S$ is an exogenous policy shock (for instance, a change in the inflation target or variation in the nominal interest rate that is not due to a response of the BoE to deviations of inflation or output growth from their target levels). K_y^S and K_Π^S are fixed weights.

The supply of money evolves according to

$$M_{t+1}^S = \mu_t^S M_t^S \tag{15}$$

where μ_t is the gross rate of growth. This is selected endogenously in order to satisfy the constraint imposed by the nominal interest rate policy.

In addition to the flexible exchange rate system we consider a monetary union by France and Germany with the UK adhering to a floating rate (we call this regime "mixed"); and a monetary union of all three countries. In a monetary union, policy is conducted according to a Taylor rule constructed as a weighed average of the rules of the participant countries. We have also experimented with an alternative rule for the Union which postulates that the union Taylor rule uses the parameters of the German rule.

2.6 The equilibrium

We now turn to the description of the equilibrium of the economy.

[6]We have also experimented with Taylor rules that include an exchange rate target. As it is commonly reported in the literature, such specifications do not find much of an independent role for exchange rate policy.

Definition 1 *An equilibrium of this economy is a sequence of prices*

$$\{\mathcal{P}_t\}_{t=0}^{\infty} = \left\{W_t^j, z_t^j, P_t^j, P_{Yt}^j, P_{bt}^j(s'), R_t^j, e_t^G, e_t^S\right\}_{t=0}^{\infty} \quad j \in (F, G, S)$$

and a sequence of quantities

$$\{\mathcal{Q}_t\}_{t=0}^{\infty} = \left\{\left\{\mathcal{Q}_t^H\right\}_{t=0}^{\infty}, \left\{\mathcal{Q}_t^F\right\}_{t=0}^{\infty}\right\}$$

with

$$\left\{\mathcal{Q}_t^H\right\}_{t=0}^{\infty} = \left\{\left\{C_t^j, I_t^j, \left\{B_{it+1}^j\right\}_{i\in(F,G,S)}, K_{t+1}^j, M_{t+1}^j\right\}_{j\in(F,G,S)}\right\}_{t=0}^{\infty}$$

and

$$\left\{\mathcal{Q}_t^F\right\}_{t=0}^{\infty} = \left\{\left\{K_t^j, h_t^j, Y_t^j, \left\{Y_{it}^j\right\}_{i\in(F,G,S)}, Q_t^j\right\}_{j\in(F,G,S)}\right\}_{t=0}^{\infty}$$

such that:

(i) given a sequence of prices $\{\mathcal{P}_t\}_{t=0}^{\infty}$ *and a sequence of shocks,* $\{\mathcal{Q}_t^H\}_{t=0}^{\infty}$ *is a solution to the representative household's problem;*

(ii) given a sequence of prices $\{\mathcal{P}_t\}_{t=0}^{\infty}$ *and a sequence of shocks,* $\{\mathcal{Q}_t^F\}_{t=0}^{\infty}$ *is a solution to the representative firms' problem;*

(iii) given a sequence of quantities $\{\mathcal{Q}_t\}_{t=0}^{\infty}$ *and a sequence of shocks,* $\{\mathcal{P}_t\}_{t=0}^{\infty}$ *clears the goods markets*

$$Q_t^F = C_t^F + I_t^F + G_t^F \tag{16}$$
$$Q_t^G = C_t^G + I_t^G + G_t^G \tag{17}$$
$$Q_t^S = C_t^S + I_t^S + G_t^S \tag{18}$$
$$Y_t^F = Y_{Ft}^F + Y_{Gt}^F + Y_{St}^F \tag{19}$$
$$Y_t^G = Y_{Ft}^G + Y_{Gt}^G + Y_{St}^G \tag{20}$$
$$Y_t^S = Y_{Ft}^S + Y_{Gt}^S + Y_{St}^S \tag{21}$$

as well as the financial, money and capital markets.

(iv) Nominal wages are set using labor contracts of the form $W_t^j = (1-\vartheta)\widetilde{W}_t^j + \vartheta E_{t-1}\widetilde{W}_t^j$ *where* $\widetilde{W}_t^j$ *is the nominal wage that would clear the labor market in a Walrasian framework, and* $0 \leqslant \vartheta \leqslant 1$ *is the share of labor contracts in the economy.*

3 Model parametrization: Calibration

We have solved the model under two sets of parameters. The first one forms the basis for most of the analysis conducted in this paper. It imposes perfect symmetry across countries in all but a single dimension. We have investigated different types of asymmetries (differences in the Taylor rules, in the properties of the exogenous shocks, etc.) but we present only the results associated with asymmetry in the degree of nominal wage flexibility as this turns out to be the most important source of asymmetry[7]. The parameter values used are similar to those typically used in the open economy literature (see Backus, Kehoe and Kydland, 1995, Chari, Kehoe and McGrattan, 2000, and Collard and Dellas, 2002). They are shown in table 1.

Table 1: Calibration I

Discount factor	β	0.998
Rate of real growth	γ	1.00672
Depreciation rate	δ	0.020
Labor share	$1-\alpha$	0.65
Substitution between domestic and foreign goods	ρ	0.25
Adjustment cost	φ	-0.174
Weight of home goods in home GDP	ϖ_{ii}	0.80
Trade interdependence between i and j	ϖ_{ij}	0.10
Persistence of technology shock	ρ_a	0.90
Volatility (sd) of technology shock	σ_a	0.008
Persistence of government spending shock	ρ_g	0.95
Volatility (sd) of government spending shock	σ_g	0.02
Money supply gross rate of growth	μ	1.0228
Interest rate smoothing	ρ_r	0.80
Inflation coefficient in Taylor rule	K_Π	1.50
Output gap coefficient in Taylor rule	K_y	0.10
Persistence of policy shock	ρ_m	0.0
Volatility (sd) of policy rule shock	σ_r	0.0024

In the second calibration, the parameter values (except of those governing the fiscal and supply shocks) are selected in order to match various features of the data. A subset of these parameters, namely, β, γ, δ, α, ρ, φ, ϖ_{ii} and ϖ_{ij}) is assumed to

[7]The remaining results can be found at http://www-vwi.unibe.ch/ amakro/resear

take the common values appearing in table 1, as differences across countries are negligible. Table 2 reports the values of the second calibration. The parameters of the Taylor rules in the three countries were selected so that the model could replicate the volatility of inflation and nominal interest rates as well as their first order autocorrelation in the data. The remaining parameters, describing the shocks in the three economies under consideration, were estimated. Both the calibration and the estimation were done over the period 1970:1–1989:4 in order to avoid the break associated with German unification. Nevertheless, the results do not differ when we carry out the calibration and estimation using the 1970-1999 sample. Note, also, that this period corresponds more or less to a period of freely floating exchange rates even for France as the exchange rate did not serve as a restriction on French monetary policy until German unification.

The supply shocks are constructed as follows. We use data on employment and the capital stock as well as the assumed value of α to build Solow residual series for the three economies. The resulting series are detrended using a deterministic trend. We then estimate a VAR(1) model of the form $\alpha_t = \rho\alpha_{t-1} + \epsilon$, namely

$$\begin{pmatrix} a_t^F \\ a_t^G \\ a_t^S \end{pmatrix} = \begin{pmatrix} \rho_{a^F a^F} & \rho_{a^F a^G} & \rho_{a^F a^S} \\ \rho_{a^G a^F} & \rho_{a^G a^G} & \rho_{a^G a^S} \\ \rho_{a^S a^F} & \rho_{a^S a^G} & \rho_{a^S a^S} \end{pmatrix} \begin{pmatrix} a_{t-1}^F \\ a_{t-1}^G \\ a_{t-1}^S \end{pmatrix} + \begin{pmatrix} \varepsilon_t^F \\ \varepsilon_t^G \\ \varepsilon_t^S \end{pmatrix} \tag{22}$$

where ρ is

$$\begin{pmatrix} 0.52 & 0.17 & 0 \\ -0.33 & 0.88 & 0 \\ 0 & 0 & 0.73 \end{pmatrix} \tag{23}$$

and the variance covariance matrix of ϵ is given by

$$\begin{pmatrix} 2.41E-05 & & \\ 1.13E-05 & 3.39E-05 & \\ 1.12E-05 & 2.74E-05 & 0.000111 \end{pmatrix} \tag{24}$$

As can be seen, volatility is much higher in the UK relative to France and Germany.

We use data on government consumption to estimate the fiscal process. The persistence parameters are

ρ_g^F	ρ_g^G	ρ_g^S
0.977	0.856	0.837

and the volatilities (sd)

σ_g^F	σ_g^G	σ_g^S
0.0205	0.025	0.023

Table 2: Calibration II: FR-DE-UK

Discount factor	β	0.998
Rate of real growth	γ	1.00672
Depreciation rate	δ	0.020
Labor share	$1-\alpha$	0.65
Substitution between domestic and foreign goods	ρ	0.25
Adjustment cost	φ	-0.174
Share of home goods in French GDP	ϖ_{FF}	0.93
Share of home goods in German GDP	ϖ_{GG}	0.94
Share of home goods in UK GDP	ϖ_{SS}	0.93
Share of French goods in German GDP	ϖ_{FG}	0.04
Share of French goods in UK GDP	ϖ_{FS}	0.035
Share of German goods in French GDP	ϖ_{GF}	0.05
Share of German goods in UK GDP	ϖ_{GS}	0.035
Share of UK goods in French GDP	ϖ_{SF}	0.02
Share of UK goods in German GDP	ϖ_{SG}	0.02
Gross growth rate of money supply	μ	1.0228
Autocorrelation in Taylor rule in France	$\rho_r F$	0.92
Inflation coefficient in Taylor rule in France	K_Π	1.19
Output gap coefficient in Taylor rule in France	K_y	0.38
Volatility (sd) of policy rule shock in France	σ_r	0.0001
Autocorrelation in Taylor rule in Germany	$\rho_r F$	0.12
Inflation coefficient in Taylor rule in Germany	K_Π	1.22
Output gap coefficient in Taylor rule in Germany	K_y	0.01
Volatility (sd) of policy rule shock in Germany	σ_r	0.0086
Autocorrelation in Taylor rule in the UK	$\rho_r F$	0.19
Inflation coefficient in Taylor rule in the UK	K_Π	1.73
Output gap coefficient in Taylor rule in the UK	K_y	0.34
Volatility (sd) of policy rule shock in the UK	σ_r	0.0065

3.1 Solution

The solution to the model involves 4 steps:

1. Adjusting the variables for both technological progress and nominal growth (that is, making the model stationary)

2. Calculating the deterministic steady state

3. Log–linearizing the system around the steady state

4. Solving the resulting dynamic system

These steps are standard. Their details appear in the technical appendix to this paper (available at the EJ web site and also at http://www-vwi.unibe.ch/amakro/resear).

The solution to the model is used to compute the impact effects of the shocks on the variables of interest (in the form of elasticities), the standard deviation of these variables and a variance decomposition of output and inflation. Using the solutions we also generate the variance covariance matrix of consumption and leisure and use it to compute welfare relying on a quadratic approximation to the utility function as suggested by Woodford, 2000.

In the next two sections we study three hypothetical economies as a means of gaining intuition about how different features of the model influence the properties of alternative monetary arrangements. For this purpose we use the parameters of the first calibration. We then turn attention to three actual economies, France, Germany and the UK and use a calibration (calibration II) that reflects the properties of these three economies.

4 The symmetric case

Here we report results in the case where all three countries are perfectly symmetric. Tables 3–4 report macroeconomic volatility and welfare under the three international monetary arrangements for high ($\vartheta = 1$) and relatively low ($\vartheta = 0.5$) nominal wage flexibility. Throughout this section we assume zero international correlation for the shocks.

Welfare is highest when all three countries participate in a monetary union. The benefits are greater when the degree of nominal wage rigidity is high, a finding that contrasts with the conventional view –owing to Friedman's celebrated case for flexible exchange rates– that the cost of monetary union is increasing in the

degree of nominal price rigidity. Note that this obtains in spite of the fact that monetary policy is active (a Taylor rule) under flexible rates. This result is due to four factors[8]. a) The more flexible the wages, the smaller the relevance of the monetary regime in place for economic activity (the closer we are to money neutrality) and welfare. Hence significant non neutralities are a precondition for the monetary regime to have significant effects. b) While a currency union amplifies the effects of country specific supply shocks on the economic activity of the participants (by inducing real wage changes even in countries that have not experienced a productivity shock), it contributes to greater output stability by limiting terms of trade effects (see below). Hence, the effect is ambiguous for supply shocks. For monetary shocks, monetary union has an advantage over the flexible exchange rate regime because such shocks are common and thus do not require terms of trade changes. c) Friedman stressed nominal exchange movements as a substitute for nominal goods price flexibility in allowing for the appropriate response of the terms of trade. In our case, the nominal rigidity is in the labor markets so the terms of trade are not hindered by the absence of exchange rate movements (specially when they are assisted by suitable monetary policy). Moreover, Friedman's argument was based on aggregate demand shocks exclusively. And d) there is direct production interdependence across countries through trade in intermediate goods. In such an environment, when an exchange rate change (a currency depreciation) has favorable effects on the demand for domestic goods it has offsetting unfavorable effects on the domestic cost of production. And e) the superior performance of monetary union obtains only under supply and money demand shocks. For fiscal shocks, a free float performs better. This is related to Poole's, 1970, analysis of money and interest rate rules for IS and LM shocks. Note that supply and monetary shocks are the dominant source of variability in our model (see the variance decompositions below in tables 7-9).

Finally, there are international spill over effects associated with the decision to or not participate in a currency union. In particular, the participants are harmed by another country's decision not to join. The "out's" level of welfare is not affected by its nonparticipation.

[8]We later explain why our result also differs from those obtained in the new Keynesian literature and which also tend to favor flexible rates.

5 Wage asymmetries

In this section we maintain the assumption that the three countries are identical in all respects except for the labor markets. In particular, we let the degree of nominal wage rigidity differ across countries. We assume that the third country (we will call it for reasons of convenience "UK") has more flexible nominal wages than the other two countries (which we will call "France" and "Germany respectively. Our parameterization in this section is as in table 1 and with $\vartheta^F = \vartheta^G = 1$ and $\vartheta^S = 0.5$.

Tables 5–6 report macroeconomic volatility and welfare and tables 7–9 the variance decompositions.

Several patterns emerge:

First, while rigid wage countries are better off in a monetary union independent of the flexible wage country's decision to participate or not (but they prefer catholic participation to a limited union), the latter is better off a on flexible exchange rate regime (independent of what the other countries do).

Second, there are spill over effects associated with a limited union. The "ins" do not reap all the benefits that would be available if everybody participated. The "out" is not affected as long as the participants are perfectly symmetric.

Third, while the limited union leaves welfare in the "out" unaffected, the reduced volatility in the union translates into a small reduction in the volatility of the nominal and real exchange rate vis a vis the "out".

What is the main reason for the increase in the volatility of real economic activity –and the accompanying reduction in welfare– in the flexible wage country (the UK) in EMU? In order to shed light on this pattern we need to look at the effects of individual shocks. For the sake of space, we have not included the tables reporting the impact effects. They can be found at the EJ web site or alternatively at http://www.vwi.unibe.ch/amakro/resear/.

Consider a positive UK productivity shock. UK output increases and the UK price deflator decreases. Under flexible rates, the BP appreciates. The appreciation works against the deterioration in the UK terms of trade that arises from the drop in the nominal price of the British goods. The net effect turns out to be a small real appreciation of the BP which reduces the expansionary effect of the productivity shock. Hence, the flexible regime has stabilizing properties.

Under EMU, the nominal exchange rate effect is absent, so the drop in British prices leads to a substantial real *depreciation* of the BP. This improves UK international competitiveness and amplifies the effect of the supply shock on output. Furthermore , this is not the only amplifying effect associated with EMU. Under flexible rates, the nominal appreciation of the BP has a negative effect on prices in the UK. This pushes the real wage up constraining the expansion in output. This channel is absent in the EMU. Consequently, UK employment expands more in EMU following a domestic productivity shock.

Consider now a positive, UK monetary shock[9]. Under flexible rates, the increase in the interest rate leads to a nominal and real appreciation of the BP, reducing employment and output in the UK. In EMU, the policy shock comes from the ECB and affects all countries. Because of differences in the degree of nominal wage rigidity across countries, the drop in nominal wages and prices is greater in the UK than in France and Germany. As a result, the UK experiences a deterioration in its terms of trade, which works against the contractionary effects of the higher interest rate. The net effect is positive and can be quite large when trade elasticities are high.

The preceding discussion suggests that ECB monetary policy may not serve the needs of all its members equally well even in the face of a common shock. To see this point, assume that the ECB responds to a uniform overheating of the Euro zone by raising the interest rate. Any given interest rate increase will have a larger contractionary effect on Germany and France than in the UK not only because of its larger –negative– effect on the real wage in those countries but also because it results in a deterioration of the UK terms of trade, which shifts demand towards the UK good.

How robust are these findings with regard to plausible changes in the parameter values? We have carried out several exercises involving changes in the parameters of the model (more detailed results are available at the web site of the EJ or at the authors' web site http://www-vwi.unibe.ch/ amakro/resear. We briefly summarize the main results but it is worth stating that the patterns documented above are not affected.

[9]Note, that due to the UK's high wage flexibility, such shocks are of less importance there. See the variance decompositions reported in tables 7-9.

The gains accruing to rigid wage economies from participation in EMU are increasing: in the elasticity of substitution between domestic and foreign goods, the degree of openness and the lack of aggressiveness in monetary policy reaction to inflation developments (a low K_π). Interestingly, unlike the standard view (see de Grauwe, 2001) the degree of cross country correlation in the shocks only plays a minor role. The same is also true regarding the degree of persistence in the shocks.

Similarly, the loss to the more flexible wage countries from participation in EMU are increasing in the elasticity of substitution between domestic and foreign goods and the lack of aggressiveness in monetary policy reaction to inflation developments (a low K_π) but decreasing in the degree of openness.

Before moving to other types of asymmetry it may be interesting to ask what type of currency partner would a rigid wage country prefer if it could chose. For instance, would it be better off forming a union with countries that are alike it or with countries that have more flexible labor markets? Table 10 reports welfare in a limited union involving one high and one low rigidity economy (that is, the other rigid wage country is left outside). The comparison of this table to 6 shows that the rigid are better off associating with the rigid.

Other types of asymmetry

In order to prepare the ground for the real world case of France, Germany and the UK that will be considered in the next section, we have also investigated the role of additional sources of asymmetry: Namely, cross country differences in the volatility of supply and monetary shocks as well as in the conduct of monetary policy. We have carried out the analysis either allowing for a single source of asymmetry or maintaining the wage asymmetry along side with the additional asymmetry. They can be summarized as follows.

First, stronger[10] inflation targeting, that is a higher K_π, increases welfare in our model. Hence, the UK's loss of adopting the Euro would be lower if the ECB were a stricter inflation pursuer than the BoE. Second, there is no significant change in the UK losses from EMU participation when the variance of the UK supply shock is higher than those in France and Germany. But while this extra relative volatility is of no consequence for the UK's decision to adopt the Euro, it matters

[10]But not too strong otherwise there is indeterminacy. As discussed by King, 2000, indeterminacy can arise when policy responds too aggressively to expectations of future inflation.

for France and Germany who no longer benefit from UK participation. Third, the same result obtains when we consider a more volatile policy shock in the UK.

6 The real world case: France, Germany and the UK

We now turn to the implications of alternative international monetary arrangements for three specific European economies, namely, France, Germany and the UK. For this purpose we use the second calibration. In this calibration we have assumed that all nominal wages in France and Germany are set in advance ($\vartheta = 1$), while in the UK, half are set in advance and the other half are flexible ($\vartheta = 0.5$). While the precise values used are arbitrary (there is widespread uncertainty about the degree of nominal wage rigidity), they reflect the presumption that the UK labor market is considerably more flexible than that in France and in Germany. We will see below that significant asymmetry in wage rigidity across countries is required in order to discourage participation in monetary union, independent of the average degree of wage flexibility in the three countries.

Tables 11-12 report the main findings[11]. The UK prefers a system in which everybody floats freely. It suffers a welfare loss when France and Germany form a currency union[12]. But the UK would suffer an even bigger loss if it became part of the union itself. Its entry, though, would be welcome by France and Germany who prefer a catholic to a limited union.

The driving force behind the finding that the UK would prefer to stay out is the assumption that the UK has considerably more flexible nominal wages than France and Germany. The other forms of asymmetry do not play a critical role. Moreover, even the absolute level of wage flexibility in the three countries does not matter much in the absence of differences in rigidity across countries. For instance, in the benchmark calibration with $\vartheta_F = 1$ and $\vartheta_G = 1$, the degree of price flexibility in the UK required to make it indifferent between joining or not joining is $\vartheta_{UK} = .6$. With the configuration $\{\vartheta_F, \vartheta_G, \vartheta_{UK}\}= \{.6, .6, .3\}$ the UK

[11]The results are robust to assuming that the ECB inherits the Taylor rule of the Bundesbank rather than using the FR-DE average. See Begg et al, 2002, for a thorough analysis of monetary policy in the Euro area.

[12]Allowing the Bank of England to target the EUR-BP rate while remaining formally outside EMU always makes the UK worse off relative to not targeting this rate.

again prefers to remain outside. With more flexible wages in the three countries but a smaller asymmetry, say, the configuration {.4, .4, .2}, the UK prefers to join. One can conclude that asymmetry in the degree of wage rigidity is more important than the absolute level of rigidity.

In our model, the world consists of three countries, all of which join or consider joining a currency union. It is of interest to modify our specification in order to have a third player outside the union when the UK participates in EMU. This is particularly important as both the current members of EMU and the UK have important trade links with the US. We have thus combined France and Germany into a single country[13], the UK as the second country and the US as the third country. We changed our parametrization accordingly. In this experiment we assumed that wage rigidity in the US was comparable to that in the UK and that there was more rigidity in France-Germany. As can be seen, adding the US does not change the UK's incentive to not participate in EMU (see table 14). That is, the UK still prefers a flexible system to forming a currency union with a country that has greater wage rigidity. It is also worth mentioning that if the UK were already in EMU and could not, for whatever reason, leave (its first best), it would welcome a currency union between the Euro zone and the other flexible wage country, the US (its second best). Off course, the UK would prefer forming a currency union with the US on its own.

Finally, we repeated the analysis using estimated rather than calibrated Taylor rules. Again, we found the UK is made worse off by joining the currency union and that this is independent of whether the ECB rule is the average of those in the three countries or simply the Bundesbank rule. Moreover, in the former case, the UK's entry is welcome by the other two countries, while in the latter, it is not. Nevertheless, given the difficulties associated with characterizing monetary policy we do not want to make too much of this finding.

6.1 Comparison to the literature

The last couple of years have witnessed a proliferation of works that use two country, general equilibrium models to study issues of monetary policy as well as

[13]By taking the average; for the Taylor rule, we also considered the case where the ECB simply adopts Bundesbank's historical rule.

international monetary arrangements. This literature uses diverse "formats" and produces even more diverse findings. Nevertheless, the main conclusion that seems to emerge from this literature (at least under producer currency pricing) is that a flexible exchange rate system with independent national monetary policies fares better than regimes that restrict exchange rate fluctuations (Begigno and Begigno, 2000, Obstfeld and Rogoff, 2001, Pappa, 2001). We, on the other hand, find that under symmetry (which is the standard assumption in this literature) monetary union is beneficial, specially when nominal wage rigidity is high.

There are three reasons for this divergence of findings. First, unlike our model where monetary policy is ad hoc, the works mentioned above assume that monetary policy is conducted optimally, that is, it aims at maximizing the utility of the representative agent. In combination with the assumption that the monetary authorities have complete information about the structure of the economy and the shocks, these models tend then to generate equilibria that replicate the efficient, flexible price (or wage) equilibrium. As Dellas (2002) has argued, when monetary policy can accomplish so much, you do not want to constraint it by making it target the exchange rate. This is specially true when beggar-thy-neighbor effects associated with independent policies are not strong (for instance, when domestic and foreign goods are poor substitutes, see Pappa, 2001).

The second reason that floating rates tend to be favored in this literature is that when prices are rigid, fixing the exchange rate takes away a mechanism that can be used to bring about desired relative price changes (Friedman's case for flexible rates). But in our case, prices are flexible (it is wages that are rigid) so that exchange rate flexibility is not as essential.

And the third reason is that, abstracting from beggar-thy-neighbor effects (which are missing from our analysis due to the non-optimizing specification of monetary policy), the ability to manipulate the nominal exchange rate is more useful when there is no production interdependence across countries. In the new literature, trade typically involves only consumption goods. As we have already explained above, the assumption of trade in intermediate goods generates offsetting effects on the cost of production following an exchange rate change, making the exchange rate instrument less useful.

6.2 Some caveats

Before concluding let us state three important caveats. First, among the reasons often offered in favor of a common currency is the elimination of the possibility of excessive, non-fundamental fluctuations in the nominal exchange rates. Our model completely abstracts from this. Very little is known about the macroeconomic and welfare implications of this possibility. To the extent that non-fundamental fluctuations in the exchange rates are substantial and have significant adverse effects, our conclusions ought to be qualified as the model would tend to bias the comparisons in favor of the flexible regime.

Second, there are other benefits associated with monetary union that our analysis has completely abstracted from. For instance, transactions costs for international but within the eurozone transactions become lower, price comparisons may become more transparent and so on. Consequently, it should be kept in mind that our welfare comparisons are conditional on the actual features of the model, not on the whole set of possible benefits and costs that have been suggested in the literature.

And third, it should be noted that the welfare differences across regimes are quite small. This is invariably the case in all general equilibrium, monetary policy models with complete asset markets and representative agents. The differences in macroeconomic volatility, on the other hand, are quite substantial.

7 Conclusion

We have studied the properties of monetary union in a three country world characterized by –possibly different degrees of– nominal wage rigidity. The main finding is that countries with high nominal wage rigidities tend to benefit from monetary union. These benefits increase with the size of the union, and also with the degree of wage rigidity in the partner countries. Flexible wage countries are welcomed but are not the preferred partners. Unlike the rigid wage countries, those with relatively more flexible nominal wages tend to fare better under flexible exchange rates. Their welfare and macroeconomic performance is not affected by what other countries do.

We have applied the analysis to France, Germany and the UK, using parameter

values that reflect the asymmetries actually observed across these three countries. We find that the UK's relatively flexible labor markets make it costly for it to form a currency union with rigid wage countries. France and Germany are better off in a monetary union. Whether they would also welcome the UK in EMU depends on the properties of the Taylor rules employed by the ECB.

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Symmetry

Table 3: Volatility, all shocks, symmetry

	High wage rigidity ($\vartheta = 1$)				Low wage rigidity ($\vartheta = 0.5$)			
	Flexible	Mixed		EMU	Flexible	Mixed		EMU
	DE-FR-UK	DE-FR	UK	DE-FR-UK	DE-FR-UK	DE-FR	UK	DE-FR-UK
Q	2.15	2.10	2.15	2.08	2.51	2.20	2.51	2.08
x	2.47	2.45	2.47	2.44	2.43	2.44	2.43	2.44
h	1.70	1.21	1.70	1.00	0.79	0.77	0.79	0.77
π	1.26	0.88	1.26	0.70	3.28	1.96	3.28	1.24
c	2.24	1.95	2.24	1.85	3.76	2.62	3.76	2.11
q	1.95	1.72	1.72	0.70	5.29	4.60	4.60	0.67
s	2.93	0.00	2.54	0.00	6.32	0.00	5.47	0.00

Note: Standard deviation of output (Q), intermediate good (x), employment (h), CPI inflation (π), consumption (c), terms of trade (q) and nominal exchange rate (s).

Table 4: Welfare, all shocks, symmetry

	High wage rigidity ($\vartheta = 1$)				Low wage rigidity ($\vartheta = 0.5$)			
	Flexible	Mixed		EMU	Flexible	Mixed		EMU
	DE-FR-UK	DE-FR	UK	DE-FR-UK	DE-FR-UK	DE-FR	UK	DE-FR-UK
Supply	-0.0332	-0.0195	-0.0332	-0.0150	-0.0140	-0.0123	-0.0140	-0.0117
Fiscal	-0.0258	-0.0268	-0.0258	-0.0271	-0.0251	-0.0254	-0.0251	-0.0255
Money	-0.1243	-0.0472	-0.1243	-0.0215	-0.0006	-0.0002	-0.0006	-0.0001
All	-0.1833	-0.0935	-0.1833	-0.0636	-0.0398	-0.0379	-0.0398	-0.0373

Note: The entries give the steady state consumption equivalent of the cost of fluctuations (multiplied by 1000).

Wage Asymmetry

Table 5: Volatility, all shocks, wage asymmetry

	Flexible		Mixed		EMU	
	DE-FR	UK	DE-FR	UK	DE-FR	UK
Q	2.16	2.49	2.10	2.49	2.09	2.10
x	2.48	2.44	2.46	2.44	2.45	2.48
h	1.74	0.80	1.28	0.80	1.11	0.85
π	1.28	3.24	0.90	3.24	0.78	1.05
c	2.25	3.73	1.96	3.73	1.87	2.01
q	1.95	3.80	0.70	3.69	0.70	0.77
s	2.93	4.78	0.00	4.55	0.00	0.00

Note: Standard deviation of output (Q), intermediate good (x), employment (h), CPI inflation (π), consumption (c), terms of trade (q) and nominal exchange rate (s).

Table 6: Welfare, wage asymmetry

	Flexible		Mixed		EMU	
	DE-FR	UK	DE-FR	UK	DE-FR	UK
Supply	-0.0352	-0.0147	-0.0215	-0.0147	-0.0177	-0.0163
Fiscal	-0.0258	-0.0252	-0.0267	-0.0252	-0.0272	-0.0253
Money	-0.1322	-0.0009	-0.0551	-0.0009	-0.0334	-0.0047
All	-0.1931	-0.0408	-0.1033	-0.0408	-0.0782	-0.0463

Note: The entries give the steady state consumption equivalent of the cost of fluctuations (multiplied by 1000).

Table 7: Variance decomposition: Flexible

k	ε_a^F	ε_a^G	ε_a^S	ε_g^F	ε_g^G	ε_g^S	ε_r^F	ε_r^G	ε_r^B
				Q^F, Q^G					
1	16.62	0.26	1.09	2.08	0.10	0.10	75.01	0.96	3.78
40	82.60	0.06	0.21	2.38	0.05	0.05	13.77	0.17	0.71
				Q^S					
1	0.06	0.06	96.85	0.08	0.08	2.24	0.26	0.26	0.11
40	0.02	0.02	97.08	0.05	0.05	2.41	0.04	0.04	0.29
				π^F, π^G					
1	62.22	0.06	0.24	0.16	0.06	0.06	32.16	1.84	3.20
40	53.80	0.05	0.16	0.12	0.04	0.04	42.71	1.12	1.96
				π^S					
1	0.41	0.41	37.19	0.02	0.02	0.05	2.53	2.53	56.84
40	0.38	0.38	37.49	0.01	0.01	0.05	2.30	2.30	57.08

Table 8: Variance decomposition: Mixed

k	ε_a^F	ε_a^G	ε_a^B	ε_g^F	ε_g^G	ε_g^B	ε_r^E	ε_r^B
				Q^F, Q^G				
1	53.33	6.39	1.17	3.07	0.00	0.10	31.85	4.09
40	89.80	1.09	0.21	2.58	0.03	0.05	5.51	0.73
				Q^S				
1	0.06	0.06	96.85	0.08	0.08	2.24	0.53	0.10
40	0.02	0.02	97.08	0.05	0.05	2.41	0.08	0.29
				π^F, π^G				
1	66.12	7.35	0.49	0.67	0.01	0.13	18.80	6.43
40	45.91	15.14	0.32	0.43	0.03	0.08	34.22	3.87
				π^S				
1	0.41	0.41	37.19	0.02	0.02	0.05	5.06	56.84
40	0.38	0.38	37.49	0.01	0.01	0.05	4.61	57.07

Table 9: Variance decomposition: EMU

k	ε_a^F	ε_a^G	ε_a^B	ε_g^F	ε_g^G	ε_g^B	ε_r^U
			Q^F,Q^G				
1	67.58	3.20	3.00	3.55	0.03	0.05	22.59
40	92.34	0.54	0.50	2.67	0.04	0.04	3.87
			Q^S				
1	0.29	0.29	94.43	0.01	0.01	2.10	2.87
40	0.07	0.07	96.84	0.03	0.03	2.38	0.58
			π^F,π^F				
1	73.74	5.39	5.06	1.13	0.06	0.09	14.53
40	43.78	10.43	9.98	0.66	0.04	0.05	35.06
			π^S				
1	7.60	7.60	51.40	0.04	0.04	1.02	32.30
40	9.86	9.86	45.80	0.05	0.05	0.91	33.47

Table 10: Choosing the right partner: Welfare comparisons

	Flexible		Mixed			EMU	
Supply	-0.0352	-0.0147	-0.0342	-0.0358	-0.0246	-0.0177	-0.0163
Fiscal	-0.0258	-0.0252	-0.0269	-0.0258	-0.0254	-0.0272	-0.0253
Money	-0.1322	-0.0009	-0.1076	-0.1330	-0.0218	-0.0334	-0.0047
All	-0.1931	-0.0408	-0.1687	-0.1945	-0.0718	-0.0782	-0.0463

Note: The entries give the steady state consumption equivalent of the cost of fluctuations (multiplied by 1000). In the mixed system (limited currency union), a rigid, $\vartheta = 1$ country (DE) forms a currency with a flexible $\vartheta = 0.5$ country (the UK); the other rigid (FR) remains outside.

Table 11: Macroeconomic volatility: DE–FR–UK, all shocks

	Flexible			Mixed			EMU		
	FR	DE	UK	FR	DE	UK	FR	DE	UK
Q	1.53	1.47	2.09	1.56	1.36	2.10	1.47	1.32	2.02
x	1.45	1.53	2.11	1.38	1.39	2.11	1.29	1.34	2.14
h	2.30	1.36	0.83	1.77	1.25	0.84	1.60	1.08	0.90
π	0.98	0.73	1.69	0.67	0.76	1.72	0.63	0.71	1.40
c	1.33	1.46	2.46	1.19	1.35	2.48	1.25	1.31	2.01
q	1.09	1.88	1.70	0.48	1.79	1.74	0.47	1.04	0.95
s	3.03	3.33	2.47	0.00	0.00	2.49	0.00	0.00	0.00

Note: Standard deviation of output, Q, employment, h, CPI inflation, π, consumption, c, terms of trade, q, and nominal exchange rate,s. In the real and nominal exchange rate rows, under each monetary regime, the first entry refers to France–Germany, the second to Germany–UK and the third to France-UK. $\vartheta_{DE} = 1$, $\vartheta_{FR} = 1$, $\vartheta_{UK} = 0.5$.

Table 12: Welfare comparisons, DE–FR–UK

	Flexible			Mixed			EMU		
	FR	DE	UK	FR	DE	UK	FR	DE	UK
Supply	-0.0291	-0.0109	-0.0326	-0.0144	-0.0122	-0.0336	-0.0198	-0.0189	-0.0342
Fiscal	-0.3069	-0.0171	-0.0108	-0.1223	-0.0237	-0.0107	-0.1092	-0.0206	-0.0126
Money	-0.0014	-0.0899	-0.0001	-0.0624	-0.0636	-0.0005	-0.0337	-0.0344	-0.0051
All	-0.3374	-0.1179	-0.0434	-0.1991	-0.0995	-0.0448	-0.1626	-0.0739	-0.0519

Note: The entries give the steady state consumption equivalent of the cost of fluctuations (multiplied by 1000). $\vartheta_{DE} = 1$, $\vartheta_{FR} = 1$, $\vartheta_{UK} = 0.5$.

8 Appendix

Table 13: Macroeconomic volatility, FR-DE zone, UK, US, all shocks

	Flexible			UK in EMU		
	FR-DE	UK	US	FR-DE	UK	US
Q	0.94	1.98	1.37	1.58	1.98	1.37
x	0.95	2.12	1.16	1.51	2.19	1.19
h	1.40	0.74	0.94	1.93	0.91	0.97
π	0.91	2.04	0.89	0.90	1.81	0.83
c	1.15	2.60	1.48	1.47	2.39	1.43
q	2.32	0.81	2.51	1.07	1.24	2.05
s	3.37	1.37	3.26	0.00	0.00	2.28

Note: Standard deviation of output, Q, employment, h, CPI inflation, π, consumption, c, terms of trade, q and nominal exchange rate,s. In the real and nominal exchange rate rows, under each monetary regime, the first entry refers to the EMU zone–UK, the second to the UK–US and the third one to the EMU zone–US.

Table 14: Welfare comparisons

	Flexible			UK in EMU		
	FR-DE	UK	US	FR-DE	UK	US
Supply	-0.1210	-0.0337	-0.0126	-0.0642	-0.0466	-0.0156
Fiscal	-0.0200	-0.0079	-0.0546	-0.0241	-0.0091	-0.0533
Money	-0.0077	-0.0002	-0.0002	-0.1952	-0.0074	-0.0025
All	-0.1487	-0.0418	-0.0674	-0.2836	-0.0631	-0.0715

Note: The entries give the steady state consumption equivalent of the cost of fluctuations (multiplied by 1000).

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