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ABSTRACT

Exchange Rate Systems and Macroeconomic Stability*

We examine macroeconomic stability and the properties of the international transmission of business cycles under three exchange rate systems: a flexible, a unilateral peg and a single currency. The subjects of study are Germany and France. EMU increases output and decreases inflation variability in Germany but it has the opposite effect in France. It induces a strong negative international transmission of country-specific supply shocks and amplifies the role of German supply shocks. These two facts may complicate ECB policy-making.

JEL Classification: E32
Keywords: flexible exchange rate, international business cycle transmission, monetary union, Taylor rules, unilateral exchange rate pegging

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NON-TECHNICAL SUMMARY

Monetary arrangements in Europe have varied considerably during the last twenty years. What began as a loose confederation of currencies in the early 1980s hardened into a DM-zone in the late 1980s and then loosened again into something akin to a flexible rate system in the early 1990s. A group of EU formed a currency union in the late 1990s with some EU members opting to remain outside and maintain a flexible parity *vis-à-vis* the euro.

Much of the recent literature on the selection of an international monetary system (exchange rate regime) has focused on whether the regime is economically sustainable and at what cost. The subject matter of this Paper, however, is more traditional, and in our view, more relevant for the EU-issue, namely what alternative sustained regimes imply for macroeconomic stability, the international transmission of business cycles and economic welfare.

There exists a voluminous literature dealing with this issue, mostly in the context of the Mundell-Fleming model. The main insight that has emerged from this literature is that the targeting of the exchange rate contributes to greater macroeconomic stability when domestic money demand shocks are the main source of volatility. For dominant domestic fiscal shocks, a flexible system fares better. Another important related finding is that, under a flexible system, fiscal shocks tend to lead to positive, and money demand shocks to negative international business cycle transmission. The opposite transmission pattern is predicted under a fixed regime.

The limitations of the original Mundell-Fleming model and its rational expectations successors are well known. As a result, the last few years have witnessed attempts to study the international aspects of the business cycle within fully specified, monetary, general equilibrium models of the world economy. Broadly speaking, the new models have confirmed – and qualified – the main insights of the Mundell-Fleming model and have also produced additional results, in particular regarding the transmission of real shocks.

The present Paper has been motivated by two observations. First, the comparison of the properties of the exchange rate regimes within general equilibrium models is still in its infancy and the properties of the single currency regime remain largely unexplored. And second, and more important, the modern literature has not asked questions of macroeconomic stability/international transmission within model economies, which have been constructed with the intention to match specific real economies. This is an important omission as the predicted patterns tend to be economic structure (parameter) specific. Policy evaluation results cannot be obtained from pure theoretical considerations. They depend on the empirical nature of the economic relations and on the size and correlation of the shocks to these relations. Unlike the real international business cycle literature, which has

produced a plethora of country-specific qualitative and quantitative results in moneyless economies, the monetary international business cycle literature has offered little information on how particular actual economies would fare under alternative monetary regimes. The practical importance of this can be hardly overestimated. For instance, the European Central Bank (ECB) must decide on the degree of flexibility of the external value of the euro. The new participants to international monetary affairs – the Eastern European countries – face the decision of selecting the optimal degree of exchange rate flexibility, and so on.

The objective of this Paper is to fill this gap. We study macroeconomic performance under three regimes (a system of flexible rates, a unilateral peg and monetary union) in a general equilibrium, two-country model with labour contracts, capital accumulation, active monetary policy (a rule *à la* Taylor) and three types of shocks: fiscal, velocity and supply. Germany and France are the subjects of this study.

We first investigate the international transmission of business cycles. The pattern is mixed for country-specific supply shocks under a flexible regime, while the transmission is negative under a fixed and a single currency system. Monetary shocks are transmitted negatively under a flexible regime but positively under a fixed regime. Fiscal shocks give rise to positive transmission independent of the exchange rate system. These findings have important consequences for the conduct of monetary policy by the ECB as negative transmission may become the source of frictions. For instance, France may object to ECB policy tightening in order to cool an overheating Germany off while she is experiencing a recession.

We then carry out a decomposition of the volatility of economic activity and prices in terms of seven shocks (the six country-specific shocks plus the common supply shock). The main source of macroeconomic instability in both Germany and France is found on the supply side, especially under EMU, with the common supply shock being more important in France and the own supply shock being more important in Germany. Interestingly, EMU increases the susceptibility of the French economy to non-French specific factors while it has the opposite effect in Germany (German specific factors become more important). Again this asymmetry might conceivably create some political difficulties for the ECB.

In the light of these findings we ask whether France and Germany would not be better off (in terms of macroeconomic stability) if they simply opted for a system of flexible rates. We find that this is indeed the case for both France and Germany for output but not for inflation performance.

One may argue that problems of monetary credibility – which we think may have been exaggerated for France, at least as recent experience is concerned – and the political ramifications of significant exchange rate movements may still offer a strong justification for the EMS or EMU (both issues have been assumed away from the Paper). This may well be the case, but our findings suggest that the choice of EMU can only draw limited defence from the main criterion of the optimum currency area, namely, macroeconomic stability.

Introduction

Changes in economic structure and preferences have often been associated with the revaluation of prevailing international monetary arrangements. This has led to considerable variation in external monetary practices both over time and across countries. The latest manifestations of this phenomenon are the formation of the European Monetary Union and the abandonment of fixed exchange rate parities in South East Asia.

There are basically two key issues concerning the selection of an international monetary system (exchange rate regime): *(i)* whether the regime is economically sustainable and at what cost, and *(ii)* what alternative, sustained regimes imply for macroeconomic stability, the international transmission of business cycles and economic welfare.

It is the latter issue that is the subject matter of this paper. There exists a voluminous literature dealing with this issue, mostly in the context of the Mundell–Fleming model. The main insight that has emerged from this literature is that the targeting of the exchange rate contributes to greater macroeconomic stability when domestic money demand shocks are the main source of volatility. For dominant domestic fiscal shocks, a flexible system fares better. The logic behind this finding is that, for aggregate demand shocks, exchange rate targeting is equivalent to interest rate targeting. And as Poole [1970] has demonstrated, interest rate targeting performs well when the main source of instability is found in the financial markets. Another important related finding is that, under a flexible system, fiscal shocks tend to lead to positive and money demand shocks to negative international business cycle transmission (Dornbusch [1988]). The opposite transmission pattern is predicted under a fixed regime[1].

The limitations of both the original Mundell–Fleming model and its rational expectations successors are well known. As a result, the last few years have witnessed attempts to study the international aspects of the business cycle within fully specified, monetary, general equilibrium models of the world economy (see Hu [1993], Shlagenhauf and Wrase [1995] for flexible price, "liquidity" versions and Stockman and Ohanian [1993], Obstfeld and Rogoff [1995], Chari, Kehoe and McGrattan [1998], and Ravn [2000], for a fixed price version of such models). Broadly speaking, the new models have confirmed — and qualified — the main insights of the Mundell- Fleming model and have also produced additional results, in particular regarding the transmission of *real* shocks.

The present paper makes four contributions. First, it examines the properties of international monetary arrangements within a model with staggered wage contracts. The existing literature relies almost exclusively[2] on an alternative friction, namely staggered goods prices with monopolistic competition and domestic currency pricing (see Betts and Devereux [2000], Devereux and Engel [2000], Duarte [2000], Pappa [2000]). For many European countries wage

[1] The standard rational expectations model with wage rigidities (Taylor [1993]) differs from the IS–LM model concerning the transmission of money shocks under a flexible exchange rate regime (it predicts positive transmission).

[2] Kollman [1996] and Obstfeld and Rogoff [1998] are among the few exceptions.

rigidities seem to be at least as -if not more- important as price rigidities. Second, it investigates the properties of the *single currency* regime, a regime that has remained largely unexplored within stochastic general equilibrium models. Third, it uses a more plausible monetary policy rule. Namely, for the first time in this literature, it allows monetary policy to be conducted according to a forward looking Taylor rule. And forth and most important, it deviates from the existing literature on alternative regimes in that it asks questions of macroeconomic stability/international transmission within model economies taht have been constructed with the intention to match specific real economies. This is an important consideration as the predicted patterns tend to be economic structure (parameter) specific. As Taylor [1993] remarks, "...policy evaluation results cannot be obtained from pure theoretical considerations. They depend on the empirical nature of the economic relations and on the size and correlation of the shocks to these relations...". Unlike the real international business cycle literature which has produced a plethora of country specific qualitative and quantitative results in moneyless economies, the monetary international business cycle literature has offered little information on how particular actual economies would fare under alternative monetary regimes. The practical importance of this can be hardly overestimated. For instance, the European Central Bank ECB must decide on the degree of flexibility of the external value of the EURO. The new participants to international monetary affairs — the eastern European countries — face the decision of selecting the optimal degree of exchange rate flexibility. And so on.

We study macroeconomic performance under three regimes (a system of flexible rates, a unilateral peg and monetary union) in a general equilibrium, two country model with labor contracts, capital accumulation, active monetary policy (a rule a la Taylor) and three types of shocks: fiscal, velocity and supply. Germany and France are the subjects of this study.

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We then carry out a decomposition of the volatility of economic activity and prices in terms of seven shocks (the six country specific shocks plus the common supply shock). The main source of macroeconomic instability in both Germany and France is found on the supply side, specially under EMU, with the common supply shock being more important in France and the own supply shock being more important in Germany. Monetary shocks are important too in France under a flexible regime, but they lose their significance in the move to EMU. Moreover, the EMU increases the susceptibility of the French economy to non-French specific factors while it has the opposite effect in Germany (German specific factors become more important). Again this asymmetry may conceivably create dilemmas in ECB policymaking.

In the light of these findings we ask whether France and Germany would not be better off (in terms of macroeconomic stability) if they had simply opted for a system of flexible rates. We find that this is indeed the case for Germany as far as output stability is concerned (but not inflation) but not for France concerning output.[3]

One may argue that problems of monetary credibility and the political ramifications of significant exchange rate movements may still offer a strong justification for the EMS or the EMU (both issues have been assumed away from the paper). This may well be the case, but our findings suggest that the choice of EMU can only draw limited defense from the main criterion of the optimum currency area, namely, macroeconomic stability.

The plan of the paper is as follows. Section 1 presents the model. Section 2 describes the characteristics of the calibration for the French and German economies. Section 3 examines the transmission mechanisms of international business cycles, whereas section 4 studies the sources of macroeconomic volatility. Section 5 addresses the question of the value of implementing EMS and EMU. A final section offers some concluding remarks.

1 The Model

1.1 Domestic Household

Household preferences are characterized by the lifetime utility function:[4]

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, \ell_t) \tag{1}$$

where $0 < \beta < 1$ is a constant discount factor, C_t denotes the domestic consumption bundle and ℓ_t is the quantity of leisure enjoyed by the representative household, which also faces the following time constraint

$$\ell_t + h_t = 1 \tag{2}$$

h_t denote hours worked. The total time endowment is constrained to 1. $U(C_t, \ell_t) : \mathbb{R}_+ \times [0,1] \longrightarrow \mathbb{R}$ is a temporal utility function, increasing and concave in its two arguments.

In each and every period, the representative household faces a budget constraint of the form

$$\int_S \left[q_t(s')B_{1t+1}(s') + e_t q_t^\star(s')B_{2t+1}(s')\right] \mathrm{d}s' + D_{1t+1} + e_t D_{2t+1} + M_{t+1} \leq B_{1t} + e_t B_{2t} \tag{3}$$

$$+R_{t-1}D_{1t} + e_t R_{t-1}^\star D_{2t} + M_t + N_t + W_t h_t + z_t K_t - P_t C_t - P_t I_t - P_t T_t \tag{4}$$

[3] In a very important piece of work (which uses a large scale, rational expectations, imperfect information, labor contracts model), Taylor [1993], finds that empirically the flexible exchange rate system brings about greater macroeconomic stability than the fixed regime in several countries (France and Germany included).

[4] $E_t(.)$ denotes mathematical conditional expectations. Expectations are conditional on information available at the beginning of period t.

where $q_t(s')$ (resp. $q_t^\star(s')$) is the price of a domestic (resp. foreign) contingent (equity) claim at the beginning of period t, B_{1t} (resp. B_{2t}) is the number of contingent claims that is owned by the domestic household at the beginning of period t. e_t denotes the nominal exchange rate between the domestic and the foreign currency. D_{1t} (resp. D_{2t}) is domestic (resp. foreign) bond holdings by the domestic household. These bonds carry a gross rate of return of R_{t-1} (resp. $R_{t-1}^\star$); W_t is the nominal wage; P_t is the nominal price of the domestic good. The household spends on consumption, C_t, and investment goods, I_t. It also pays lump-sum taxes, T_t and receives a nominal lump–sum transfer, N_t, from the monetary authorities. It also receives income from leasing capital, K_t, to the firms at the rate of z_t. Finally, the household enters period t with an amount of money, M_t, carried over from the previous period and ends the period with an amount M_{t+1}.

Money is held because of a cash–in–advance (CIA) constraint on consumption purchases. This constraint takes the form

$$P_t C_t \leq M_t \tag{5}$$

Note that money spent in period $t+1$ must be acquired in period t.

Capital accumulates according to the law of motion

$$K_{t+1} = \Phi\left(\frac{I_t}{K_t}\right) K_t + (1-\delta) K_t \tag{6}$$

where $\delta \in [0,1]$ denotes the rate of depreciation. The concave function $\Phi(.)$ reflects the presence of adjustment costs to investment. It is assumed to be twice differentiable and homogeneous of degree 0. Furthermore, we impose two assumptions that guarantee the absence of adjustment costs in the steady state: $\Phi(\gamma+\delta-1) = \gamma+\delta-1$ and $\Phi'(\gamma+\delta-1) = 1$.

The behavior of the foreign household is similar.

1.1.1 The domestic representative firm

The domestic representative firm specializes in the production of a homogeneous "intermediate" good according to:

$$Y_t \leq A_t K_t^\alpha (\Gamma_t h_t)^{1-\alpha} \tag{7}$$

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 is a stationary, exogenous, stochastic technological shock. The labor index h_t is an aggregate of a continuum of labor types:

$$\log(h_t) = \int_0^1 log\ (h_t(i))\mathrm{d}i$$

where labor type $i \in (0,1)$ is characterized by the period at which the labor contract has been signed.

The representative firm chooses how much capital and labor to lease in period t in order to maximize its expected present value

$$E_0 \sum_{t=0}^{\infty} \rho(0,t)(P_{1t}Y_t - W_t h_t - z_t K_t) \tag{8}$$

where P_{1t} is the price of the domestic intermediate good and

$$\rho(0,t) = \prod_{\ell=0}^{t} \frac{p_{s\ell}}{p_{s\ell+1} + d_{\ell+1}}$$

The foreign representative firm acts in a similar way. Following Backus et al. [1992], we assume that the domestic, Y_1, and foreign, Y_2, intermediate goods are combined to produce a domestic, final good, Q, (Q^* in the foreign country) which can be used for consumption and investment purposes. Final good production at home is described by the following CES function

$$Q_t = \left(\omega^{1-\rho} {Y_{1t}}^{\rho} + (1-\omega)^{1-\rho} {Y_{2t}}^{\rho}\right)^{1/\rho} \tag{9}$$

and abroad by

$$Q_t^\star = \left(\omega^{1-\rho} Y_{2t}^{\star\rho} + (1-\omega)^{1-\rho} Y_{1t}^{\star\rho}\right)^{1/\rho} \tag{10}$$

$Y_{it}^\star$ denotes the quantity of intermediate good i used in the production of the foreign final good. $\rho \leqslant 1$ is the elasticity of substitution between domestic and foreign intermediate goods, and $\omega \in (0,1)$ is the share of the domestic intermediate good.

1.1.2 The government

In each and every 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:

$$\log(g_t) = \rho_g \log(g_{t-1}) + (1-\rho_g)\log(g) + \varepsilon_{gt} \tag{11}$$

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

These expenditures are financed by means of lump–sum taxation, such that

$$P_t G_t = P_t T_t \tag{12}$$

1.1.3 The monetary authorities

The behavior of the monetary authorities depends on the international monetary arrangement in place. We examine three regimes: A flexible, a unilateral peg (by France), and a single currency system. Monetary authorities are assumed to pursue active monetary policy. In particular, central banks are assumed to follow a Taylor rule of the form

$$\log(R_t) = \rho_r \log(R_{t-1}) + (1-\rho_r)\left(\log R + \kappa_y E_t \widehat{y}_{t+1} + \kappa_\pi E_t\left(\log(\pi_{t+1}) - \log(\pi)\right)\right) + \varepsilon_{rt} \quad (13)$$

where R_t is the gross nominal interest rate, $\widehat{y}_t$ is the output gap[5], π_t is the CPI based inflation rate and π is the inflation rate target.

In all cases we will assume that the supply of money involves according to

$$M_{t+1} = \mu_t M_t \quad (14)$$

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. Under a unilateral peg, France is assumed to select the growth rate of its supply of money, μ_t, in order to maintain a fixed FF/DM parity (while Germany pursues its Taylor rule). This policy is implemented by solving for the exchange rate as a function of the state variables of the system (a set that includes μ_t) and then selecting a value for μ_t that satisfies the exchange rate target, e.

1.2 Nominal Wage Contracts

We assume that the nominal wage is set using a nominal wage contract mechanism *à la* Calvo (1983). In this setting, contracts can remain unchanged with probability (1-p) or end with probability p in each and every period. In the latter case, the contract is renegotiated on the basis of the available information at that time. It thus follows that $p(1-p)^j$ is the fraction of households having a wage contract of age j. We thus have contracts that last for several periods and end randomly. A contract signed at time t is just the sum of all expected Walrasian wages, weighted by the surviving probability of the contract

$$\log(\chi_t) = \sum_{i=0}^{\infty} p(1-p)^i E_t \log\left(\widetilde{W}_{t+i}\right) \quad (15)$$

where $\widetilde{W}_t$ denotes the Walrasian wage in period t. Therefore, a contract of age j at time t stipulates a fixed nominal wage agreed upon at time $t-j$, χ_{t-j}. Under such a contract the household agrees to supply the amount of labor demanded by the firm.

Let W_t denote the average contractual wage, and $W_t(i)$ the contractual wage of household i. From the maximization problem of the firm we have:

$$W_t(i) = (1-\alpha)\frac{Y_t}{h_t(i)}$$

An implication of this formulation is that labor income, $W_t(i)h_t(i)$, is the same across all households.[6] Then, taking logarithms in the previous equation and aggregating over labor

[5] $\widehat{y}_t = \log(Y_t) - \log(\overline{Y}_t)$, where $\overline{Y}_t$ denotes potential output, modeled as a linear trend.

[6] Another implication of this property is that the dynamic behavior of all individuals will be the same.

types, we get:

$$\log(W_t) = \int_0^1 \log(W_t(i))\mathrm{d}i$$

As in each period, a fraction p of contracts end, there are $p(1-p)$ contracts surviving from period $t-1$, and therefore $\pi(1-\pi)^j$ from period $t-j$, so that the average wage is:

$$\log(W_t) = \sum_{i=0}^{\infty} p(1-p)^i E_t \log\left(\chi_{t-i}\right) \tag{16}$$

1.3 The equilibrium

We now turn to the description of the equilibrium of the economy. Recall that capital is perfectly mobile across countries while labor is not.

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

$$\{\mathcal{P}_t\}_{t=0}^{\infty} = \{W_t, W_t^\star, z_t, z_t^\star, P_t, P_t^\star, P_{1t}, P_{2t}^\star, p_{st}, p_{st}^\star, e_t, R_t, R_t^\star, d_t, d_t^\star\}_{t=0}^{\infty}$$

and a sequence of quantities

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

with $\{\mathcal{Q}_t^H\}_{t=0}^{\infty} = \{C_t, C_t^\star, I_t, I_t^\star, G_t, G_t^\star, S_{1t+1}, S_{1t+1}^\star, S_{2t+1}, S_{2t+1}^\star, K_{t+1}, K_{t+1}^\star, h_t, h_t^\star, M_{t+1}, M_{t+1}^\star\}_{t=0}^{\infty}$ *and* $\{\mathcal{Q}_t^F\}_{t=0}^{\infty} = \{Y_t, Y_t^\star, Y_{1t}, Y_{1t}^\star, Y_{2t}, Y_{2t}^\star, , Q_t, Q_t^\star, K_t, K_t^\star, h_t, h_t^\star\}_{t=0}^{\infty}$ *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*

$$Q_t = C_t + I_t + G_t \tag{17}$$
$$Q_t^\star = C_t^\star + I_t^\star + G_t^\star \tag{18}$$
$$Y_t = Y_{1t} + Y_{1t}^\star \tag{19}$$
$$Y_t^\star = Y_{2t} + Y_{2t}^\star \tag{20}$$

and also the financial and capital markets.

(iv) Wages are set using labor contracts (15)–(16).

2 Calibration

The model is calibrated using quarterly data for two European economies: France and Germany. The sample[7] runs from 1970:1 to 1994:4. We assume that both economies share the same structural parameters except for the shocks. This implies that we will work with average ratios when calibrating the economy.

β, the discount factor in the stationary economy, is set such that households discount the future at a 4% annual rate. ρ determines the elasticity of substitution between foreign and domestic goods. We set this elasticity of substitution to 1.5, which implies a value of ρ equal to 1/3.[8] $1-\omega$ corresponds to the share of total imports in output. We set this equal to 21.6% in order to match the empirical counterpart during that period.

The instantaneous utility function is assumed to be of the form

$$U(C_t, \ell_t) = \log(C_t) + \nu \log(\ell_t) \tag{21}$$

where ν, the parameter that determines the relative weight of consumption valuation in the temporal utility function, is set such that households spend 35% of their total time endowment working.

$1-\alpha$, the labor share is set to 0.64 in order to match its empirical counterpart during that period. γ, the deterministic factor of growth, is set such that the average economy experiences a 2.58% annual rate of growth. δ is set to 0.0125 corresponding to a value used in previous studies for both the French and the German economies. φ the elasticity of marginal capital adjustment cost was set such that the model matches the relative French volatility of investment under a flexible exchange rate regime (for a high elasticity of substitution between foreign and domestic goods). This implies a value of $\varphi = -0.1595$.

The average growth of nominal balances is set equal to 8.4% per year according to the data. The share of public expenditures is set to 19.3% corresponding to the historical value over the sample.

p, the probability that a contract expires is set such that the average duration of a contract is 4 quarters.[9]

We now turn to the structure of shocks. Concerning the technological shocks, we use the data and values for α to build Solow residual series for the French and the German economies. The data are filtered for a deterministic trend. We then estimate a VAR(1) model of the form:

$$\begin{pmatrix} \log(A_t) \\ \log(A_t^\star) \end{pmatrix} = \begin{pmatrix} \rho_a & \psi_a \\ \psi_a & \rho_a \end{pmatrix} \begin{pmatrix} \log(A_{t-1}) \\ \log(A_{t-1}^\star) \end{pmatrix} + \begin{pmatrix} \varepsilon_{ct} + \varepsilon_{at} \\ \varepsilon_{ct} + \varepsilon_{at}^\star \end{pmatrix}$$

[7] The results do not differ when a shorter sample is used (until 1989). It is not clear which period best corresponds to a perfectly flexible regime.

[8] Results for a low elasticity of 0.5 (ρ=-1) are available at *http://www-vwi.unibe.ch/amakro/dellas.htm*

[9] The results with contracts with duration of 1 and 8 quarters can be found at: *http://www-vwi.unibe.ch/amakro/dellas.htm*. The main qualitative patterns are robust with regard to the choice of the duration parameter.

where $|\rho_a| < 1$, $|\psi_a| < 1$, $|\rho_a - \psi_a| < 1$ and $|\rho_a + \psi_a| < 1$ for sake of stationarity. $\varepsilon^{\star}_{ct}$ is a shock common to the two economies under study and ε_{at} and $\varepsilon^{\star}_{at}$ are two country specific shocks. We do not have access to reliable data on the capital stock in France and Germany. We assigned values to the parameters defining the technology shocks as follows: ρ_a and ψ_a are respectively set to 0.75 and 0.2, so that the technology shock exhibits a first order serial correlation of 0.95, a value commonly used in the literature. The volatilities of the specific shocks are set by matching the volatility of the French and German outputs and the volatility of the common shock is set to make the model matches the cross–country correlations of output (see table 1), under a flexible exchange rate regime[10].

Table 1: Volatilities of technology shocks

$E(\varepsilon_c^2)$	$E(\varepsilon_a^2)$	$E(\varepsilon_a^{\star 2})$
2.9522e-05	0.3480e-05	1.0669e-04

The government expenditure processes were estimated using series for the government consumption purchases. They take the form of AR(1) and their properties are reported in table 2

Table 2: Fiscal shocks

ρ_g	$\rho_g^{\star}$	$E(\varepsilon_g^2)$	$E(\varepsilon_g^{\star 2})$
0.9834	0.9388	0.1443E-04	0.5517e-04

Finally the parameters of the nominal interest rate rule were estimated[11] using GMM. $\log(\overline{Y}_t)$ corresponds to a linear trend and $\log(\pi)$ to the average CPI inflation over the sample period. R_t is the interbank money rate in France and the Lombard rate in Germany. π_t is the CPI based inflation rate. The coefficients of the rule are reported in table 3.

As can be seen, these rules are similar to other "Taylor" type rules reported in the literature (e.g. Clarida, Gali and Gertler [1998]). According to the estimated rules, both central banks place a greater weight on expectations about inflation. The French central bank follows a rather more aggressive short term monetary policy[12].

Under EMU, the ECB is assumed to use a policy rule whose parameters are the weighted average of the two national rules, with equal weights.

[10] For the high elasticity of substitution between foreign and domestic goods and for the benchmark of one period wage contracts.

[11] Because of data problems, the sample used in the estimation of the Taylor rules covers the 1983-1994 period.

[12] Not in terms of the average inflation target but in terms of deviations from that target.

Table 3: Taylor rules

	ρ_r	κ_y	κ_π	J–Stat	$E(\varepsilon_r^2)$
Germany	0.7916	0.06831	1.2200	6.99	0.6754e-06
	(0.0382)	(0.0252)	(0.3472)	[63.83]	
France	0.8069	0.1910	1.8802	7.19	0.1174e-05
	(0.0489)	(0.0511)	(0.3945)	[61.66]	

Note: standard deviation in parenthesis
p–value in brackets

The model is log–linearized around its deterministic steady state. The resulting linear, dynamic system is then solved using the method of Blanchard and Kahn [1980].

3 The transmission of disturbances

This section is devoted to the analysis of transmission of shocks across countries. Tables 4–7 report the impact elasticity of output, inflation, nominal interest rate, the nominal exchange rate and the terms of trade with regard to each shock under each international monetary arrangement. Seven exogenous shocks are considered: Country specific productivity, government expenditure and monetary shocks; and a common supply shock. We report results for a high elasticity of substitution between domestic and foreign goods for an economy with Calvo labor contracts that have an average duration of 4 quarters.[13]

3.1 Common supply shocks

Consider first a common, positive supply shock that hits the two economies simultaneously. While output in both economies increases and the inflation rate decreases, an important asymmetry arises. Namely, French output responds more than the German (0.98 vs 0.69) while French inflation responds less than the German (-1.36 vs -2.22). The asymmetric response is due to differences in the conduct of monetary policy in the two countries (see table 3). First, note that monetary policy is procyclical. A positive supply shock decreases inflation below its target level and induces expansionary monetary policy. The fact that the French central bank reacts more aggressively than the German Bank to deviations of expected inflation from target implies more expansionary policy in France (a lower real interest rate), a lower reduction in inflation and a larger expansion in output.

The common supply shock also weakens the French Franc. Under a unilateral exchange rate pegging (UERP) regime, the French central bank must prevent the depreciation of the French franc. This requires *contractionary* monetary policy which exaggerates the reduction

[13] The reader is referred to http://www-vwi.unibe.ch/amakro/resear/resea.htm for results obtained with 1 and 8 quarters.

Table 4: Common supply shocks

	FER	UERP	EMU[(a)]
Y	0.983	0.702	0.816
$Y^\star$	0.692	0.702	0.816
π	-1.358	-1.831	-1.646
$\pi^\star$	-2.227	-1.831	-1.646
Δe	1.101	—	—
eP_2/P_1	0.408	0.000	-0.000
R	-0.139	—	—
$R^\star$	-0.139	-0.139	-0.131

(a) In the case of EMU, the reported interest rate rule corresponds to that of the ECB.

in French inflation (-1.83 under UERP versus -1.35 under FER). With fixed nominal wages, the larger reduction in inflation translates into a larger increase in the real wage rate, which restrains the increase in the demand for labor (that arises form higher productivity) and hence output. At the same time, the stabilization of the nominal exchange rate limits the degree of real depreciation of the French Franc, limiting the gains in French competitiveness. Both of these effects make the response of French output to be smaller under UERP (0.70) than under FER (0.98). Hence, the fixed exchange rate regime stabilizing the French economy in the face of common supply shocks.

The response of output in greater in Germany nut smaller in France under EMU relative to that under a flexible system. This is due to the fact that the ECB policy is more procyclical than that of the Bundesbank but less procyclical of that of the French central bank under flexible rates.

3.2 Specific supply shocks

Consider first a positive French supply shock under a flexible exchange rate system. It increases domestic employment and output, lowers the rate of inflation and leads to a nominal appreciation but a real depreciation of the French Franc. The improvement in French trade competitiveness (real depreciation) shifts demand away from the German good -as long as domestic and foreign goods are good substitutes- and is detrimental to German output (-0.12). Interestingly, the transmission of German specific supply shocks to France is positive because even in this case the French terms of trade deteriorate. This is due to the asymmetry of monetary policies across the two countries. The initial effect of the German supply shock is to make German goods cheaper (improve the French terms of trade). This decreases both inflation and output in France, making the French central bank respond with expansionary monetary policy. The German central bank also responds with expansionary monetary policy too, but its response is smaller because of two reasons. First, the German bank is less "aggressive" (see the Taylor rule); and second, there is a conflict between what expected inflation and expected output dictate.

Table 5: Specific supply shocks

	FER		UERP		EMU[(a)]	
	ε_a	$\varepsilon_a^\star$	ε_a	$\varepsilon_a^\star$	ε_a	$\varepsilon_a^\star$
Y	0.750	0.233	1.168	-0.466	1.059	-0.243
$Y^\star$	-0.123	0.816	-0.134	0.837	-0.243	1.059
π	-1.563	0.205	-0.904	-0.927	-1.052	-0.594
$\pi^\star$	0.127	-2.354	-0.447	-1.384	-0.594	-1.052
Δe	-1.565	2.666	—	—	—	—
eP_2/P_1	0.220	0.189	0.805	-0.805	0.805	-0.805
R	-0.063	-0.076	—	—	—	—
$R^\star$	-0.064	-0.076	-0.066	-0.073	-0.066	-0.066

(a) In the case of EMU, the reported interest rate rule corresponds to that of the ECB.

Under UERP, the French monetary authorities must prevent the appreciation of the French Franc vis a vis the German Mark by following expansionary monetary policy. This prevents the domestic nominal prices from dropping too much, impeding the increase in real wages and thus leading to an even greater expansion of French output relative to the FER case. Hence, a fixed exchange rate regime amplifies the effects of the French supply shock on Frenchc economic activity (column 2 of table 5).

At the same time, the transmission of the international business cycle is always negative under a UERP, independent of the origin of the shock. Unlike the flexible exchange rate regime case where a positive shock in Germany was followed by expansionary monetary policy in France, monetary policy in France under UERP must tighten in order to counter the appreciation of the DM.

Negative transmission also occurs under a single currency. A regional positive supply shock decreases inflation throughout the union. With a given nominal wage, this brings about higher real wages even in the areas that have not experienced the productivity improvement, discouraging employment and lowering output (columns 6 and 7, table 5).

While the cross country correlation of inflation movements induced by productivity shocks is negative under a flexible regime, it is, as expected, positive under a fixed and single currency systems.

The comparison between a flexible system and a currency union regarding the impact effects of a country specific supply shock on domestic economic activity and inflation reveals an interesting pattern. The effects on output are larger and those on inflation smaller under EMU. In a sense, the "aggregate demand" curve in each country becomes flatter under the latter regime, or equivalently, monetary policy becomes more "accommodating". This is due to the disappearance of the nominal exchange rate appreciation effect on the terms of trade, a factor that restrained the improvement in trade competitiveness.

3.3 Monetary shocks

Under a flexible system, a positive, domestic, monetary shock - that is, an increase in the domestic interest rate- puts downward pressure on domestic demand as *(i)* investment becomes more expensive and *(ii)* intertemporal substitution effects motives lead the household to postpone consumption. This therefore decreases domestic inflation, increases real wages and leads to a contraction in domestic output. The domestic currency appreciates and the terms of trade improve. The resulting switch in expenditure towards the cheaper foreign good increases its nominal price. Given a fixed foreign nominal wage, this lowers real wages abroad and stimulates output. The international business cycle transmission is therefore *negative* (table 6).

Table 6: Money shocks

	FER		UERP		EMU[(a)]
	ε_r	$\varepsilon_r\star$	ε_r	$\varepsilon_r^\star$	ε_r
Y	-3.315	1.626	0.000	-2.697	-2.321
$Y^\star$	0.060	-2.779	0.000	-2.697	-2.321
π	-4.937	3.002	0.000	-3.486	-2.982
$\pi^\star$	4.410	-9.261	0.000	-3.486	-2.982
Δe	-11.919	15.629	—	—	—
eP_2/P_1	-4.527	5.924	0.000	0.000	-0.000
R	0.611	-0.115	—	—	—
$R^\star$	-0.010	0.591	0.000	0.584	0.546

(a) In the case of EMU, the reported interest rate rule corresponds to that of the ECB. The money shock is that affecting the rule of the ECB.

Under UERP the French money shock is fully offset by appropriate monetary policy preventing any effects on French (and German) economic activity (column 4 of table 6). In order to offset the effect of a positive German money shock on the exchange rate - *i.e.* in order to prevent the appreciation of the DM- the French monetary authorities must raise interest rates. This leads to a drop in prices in France. As a result, given the fixity of nominal wages, real wages increase, employment is discouraged and French output decreases. UERP induces *positive* international transmission.

In a currency union, common money shocks lead to perfectly symmetric changes in economic activity and prices across regions.

3.4 Fiscal shocks

Fiscal shocks tend to have smaller effects than supply and money shocks[14]. Under FER, a positive French fiscal shock brings about an increase in output. As in the Mundell–Flemming model, fiscal expansion makes the domestic currency experience a nominal and real exchange rate appreciation. Foreign goods become cheaper and the associated switch toward foreign goods translates into higher foreign prices, lower real wages and higher output (positive international business cycle transmission).

Table 7: Fiscal shocks

	FER		UERP		EMU$^{(a)}$	
	ε_g	$\varepsilon_g^\star$	ε_g	$\varepsilon_g^\star$	ε_g	$\varepsilon_g^\star$
Y	0.077	0.028	0.107	0.028	0.097	0.025
$Y^\star$	0.040	0.090	0.038	0.090	0.028	0.087
π	-0.005	0.026	0.055	0.027	0.034	0.020
$\pi^\star$	0.073	0.053	0.026	0.052	0.006	0.046
Δe	-0.135	-0.001	—	—	—	—
eP_2/P_1	-0.099	0.044	-0.051	0.045	-0.051	0.045
R	-0.008	-0.000	—	—	—	—
$R^\star$	-0.002	0.001	-0.002	0.001	-0.006	-0.001

(a) In the case of EMU, the reported interest rate rule corresponds to that of the ECB.

Under UERP, the French monetary authorities must prevent the appreciation of the French Franc vis a vis the German Mark by pursuing expansionary monetary policy, which increases prices and decreases real wages in France. The change in output is thus larger (0.10 under UERP and 0.077 under FER). Hence, as in the case of money and country specific supply shocks, UERP leads to the amplification of the French business cycle. Nevertheless, the transmission of the international business cycle is always positive.

The same expenditure switch effect is also present under EMU, causing positive output and inflation comovements across countries.

To summarize: A French unilateral fixed exchange rate regime amplifies the impact of both country specific supply shocks as well as that of foreign fiscal shocks on French aggregate activity. On the other hand, it insulates the French economy against domestic money shocks and common supply shocks. Depending on the relative importance (volatility) of all these shocks, a fixed regime may or may not contribute to greater macroeconomic stability.

[14]This would be true even under distortionary income taxation. As long as we maintain the assumption that employment is demand determined (under fixed wages), changes in income taxes will have no direct effects on employment and output.

4 Sources of macroeconomic variability: Variance decomposition

In order to characterize the forces that drive the business cycle and to produce a better understanding of the overall dynamics of the model, we report in tables 8–10 the variance decompositions for output and inflation under alternative international monetary arrangements. Seven exogenous shocks are considered: Country specific productivity, government expenditure and monetary shocks; and a common supply shock.

The supply shocks are the dominant source of macroeconomic volatility under all three exchange rate systems. Monetary shocks also play some role, but only in France, in the short run under a flexible exchange rate regime. Fiscal shocks, on the other hand, tend to have a negligible impact. Several additional interesting patterns emerge which are described below.

4.1 Flexible system

First, nominal shocks are a more important source of short term variation in economic activity in France than in Germany. Whatever their short term importance, though, their effects quickly fade out, ending up having a minor contribution to output volatility in the longer term (about 3%-4% at 40 quarters). They do matter, however, for French inflation volatility even in the long run.

Second, the contribution of the common supply shock is considerably higher in France in the short run. The own country shock, on the other hand, is much more important in Germany (compare columns 2, 3 and 4 in table 8). Moreover, German developments exert a much greater influence on French economic activity than vice versa (columns 3 and 4 in table 8). As a result, *pure* French influences account for less than 5% of long term French output volatility while the corresponding figure for Germany is more than 50%. Moreover, Germany matters a lot for the French business cycle while France does not matter for the German one.

4.2 Fixed regime

The move to the UERP regime brings about significant changes to France concerning her sources of variation in economic activity and inflation.. It makes her somewhat more vulnerable to domestic supply factors. It increases dramatically the contribution of the German shock at the expense of the common shock in the very short run but this pattern is reversed in the medium-long term. The German specific supply shock now accounts for about 50% of the short run French output and inflation variability (the corresponding medium term figures are 40% and 50%). Interestingly, the UERP has no effect on the structure of volatility in Germany (other than the increase in the contribution of the common shock to inflation variability).

4.3 Single currency

A currency union is associated with two important new patterns in comparison to the fixed regime:

First, monetary shocks become even less important relative to supply shocks. This comes from the combination of two elements: That German supply shocks have greater volatility. And ECB policy is more aggressive (more procyclical) against supply shocks than the German central bank.

Second, EMU partially insulates short run French output and inflation from German specific supply shocks but it makes her more vulnerable to common disturbances.

And third, the contribution of German supply factors to French volatility remains very high while that of French factors on German economic activity remain minor. EMU will not remove France's dependence on German developments.

Finally, in comparison to a flexible regime, EMU makes France more susceptible to non-French specific shocks (common supply and German specific supply shock).

4.4 Policy implications

The findings reported above have important implications for the conduct of monetary policy by the European Central Bank.[15] First, the fact that country specific supply shocks induce negative comovements in economic activity across countries may create French–German conflicts concerning the type of monetary policy that ought to be pursued by the ECB. It may be hard for a country to accept a contraction as a result of ECB actions that aim at preventing overheating in the other country. The relative importance of national shocks, in particular in Germany, means that there will be many opportunities for such conflicts to materialize. Second, the flattening of the national "aggregate demand curves" that is associated with the move to a single currency also implies that while EMU will stabilize inflation, it will create higher instability in economic activity. And third, the increase in the importance of supply factors under EMU implies that inflation and economic activity will be negatively correlated, making the pursuit of the inflation policy a harder sell. On the positive side, the fact that common supply shocks are very important tends to reduce the scope of policy frictions (the optimum currency area argument).

5 EMS and EMU: A good idea?

What do the results above imply for the ranking of alternative international monetary arrangements from the point of view of macroeconomic variability?

Table 12 reports the volatility of several macroeconomic variables. The main finding is that the unilateral peg did not have much of an effect on output stability in either country

[15] Although not explicitely included in our model -because we do not model the objectives of the central bank - these practical considerations may be of interest.

Table 8: Variance decomposition: FER

			Y				
k	ε_c	ε_a	$\varepsilon_a^\star$	ε_g	$\varepsilon_g^\star$	ε_r	$\varepsilon_r^\star$
1	55.84	3.83	11.36	0.17	0.09	25.23	3.48
4	43.58	1.64	36.48	0.13	0.06	16.65	1.46
8	44.95	1.38	43.57	0.15	0.04	9.14	0.77
20	47.39	1.40	45.48	0.20	0.03	5.09	0.41
40	48.08	1.41	45.77	0.26	0.02	4.12	0.34
			$Y^\star$				
k	ε_c	ε_a	$\varepsilon_a^\star$	ε_g	$\varepsilon_g^\star$	ε_r	$\varepsilon_r^\star$
1	15.57	0.06	78.11	0.03	0.50	0.01	5.72
4	26.67	0.60	58.27	0.05	0.68	0.32	13.41
8	39.12	1.18	50.73	0.04	0.53	0.22	8.18
20	45.70	1.40	48.18	0.04	0.34	0.12	4.22
40	47.02	1.43	47.80	0.05	0.28	0.09	3.33
			π				
k	ε_c	ε_a	$\varepsilon_a^\star$	ε_g	$\varepsilon_g^\star$	ε_r	$\varepsilon_r^\star$
1	53.30	8.33	4.38	0.01	0.04	28.02	5.92
4	51.88	7.14	11.88	0.02	0.04	23.99	5.05
8	51.72	6.79	14.11	0.03	0.03	22.56	4.76
20	51.66	6.32	17.03	0.04	0.03	20.57	4.35
40	51.63	6.09	18.49	0.06	0.03	19.58	4.12
			$\pi^\star$				
k	ε_c	ε_a	$\varepsilon_a^\star$	ε_g	$\varepsilon_g^\star$	ε_r	$\varepsilon_r^\star$
1	17.89	0.01	72.22	0.01	0.02	2.79	7.06
4	18.87	0.06	71.36	0.01	0.02	2.70	6.98
8	19.26	0.08	71.06	0.01	0.02	2.67	6.90
20	19.91	0.10	70.58	0.01	0.02	2.62	6.76
40	20.31	0.12	70.27	0.01	0.02	2.59	6.68

Table 9: Variance decomposition: UERP

			Y				
k	ε_c	ε_a	$\varepsilon_a^\star$	ε_g	$\varepsilon_g^\star$	ε_r	$\varepsilon_r^\star$
1	30.62	9.99	48.65	0.35	0.10	10.29	
4	42.65	8.58	33.42	0.43	0.09	14.83	
8	52.79	5.59	33.50	0.35	0.06	7.71	
20	54.25	3.60	38.21	0.32	0.03	3.59	
40	54.43	3.21	39.19	0.38	0.03	2.76	
			$Y^\star$				
k	ε_c	ε_a	$\varepsilon_a^\star$	ε_g	$\varepsilon_g^\star$	ε_r	$\varepsilon_r^\star$
1	15.39	0.07	78.87	0.03	0.48	5.16	
4	26.36	0.45	63.38	0.03	0.62	9.16	
8	37.89	0.98	55.09	0.03	0.48	5.53	
20	44.57	1.25	50.88	0.04	0.32	2.94	
40	46.08	1.32	49.95	0.04	0.26	2.35	
			π				
k	ε_c	ε_a	$\varepsilon_a^\star$	ε_g	$\varepsilon_g^\star$	ε_r	$\varepsilon_r^\star$
1	49.06	1.42	45.43	0.03	0.03	4.03	
4	44.59	1.15	50.42	0.02	0.02	3.80	
8	44.65	1.15	50.53	0.02	0.02	3.63	
20	45.09	1.17	50.28	0.02	0.02	3.42	
40	45.37	1.19	50.10	0.02	0.02	3.30	
			$\pi^\star$				
k	ε_c	ε_a	$\varepsilon_a^\star$	ε_g	$\varepsilon_g^\star$	ε_r	$\varepsilon_r^\star$
1	31.68	0.23	65.43	0.01	0.05	2.60	
4	33.03	0.32	63.78	0.01	0.05	2.81	
8	33.60	0.36	63.26	0.01	0.05	2.72	
20	34.47	0.42	62.45	0.01	0.05	2.60	
40	35.00	0.45	61.96	0.01	0.05	2.53	

Table 10: Variance decomposition: EMU

			Y			
k	ε_c	ε_a	$\varepsilon_a^\star$	ε_g	$\varepsilon_g^\star$	ε_r
1	60.38	12.01	19.44	0.43	0.11	7.63
4	65.28	7.43	18.40	0.39	0.08	8.42
8	59.80	4.21	31.98	0.30	0.05	3.66
20	56.28	2.84	38.89	0.29	0.03	1.67
40	55.54	2.57	40.22	0.35	0.02	1.30
			$Y^\star$			
k	ε_c	ε_a	$\varepsilon_a^\star$	ε_g	$\varepsilon_g^\star$	ε_r
1	13.79	0.15	84.02	0.01	0.30	1.73
4	21.54	0.20	75.13	0.01	0.35	2.77
8	30.81	0.54	66.44	0.02	0.31	1.88
20	38.40	0.87	59.32	0.03	0.24	1.14
40	40.48	0.96	57.39	0.03	0.20	0.94
			π			
k	ε_c	ε_a	$\varepsilon_a^\star$	ε_g	$\varepsilon_g^\star$	ε_r
1	63.65	3.07	29.99	0.02	0.02	3.25
4	58.48	2.59	35.77	0.02	0.02	3.12
8	57.90	2.51	36.59	0.02	0.02	2.96
20	57.39	2.43	37.40	0.03	0.02	2.73
40	57.13	2.39	37.82	0.04	0.02	2.60
			$\pi^\star$			
k	ε_c	ε_a	$\varepsilon_a^\star$	ε_g	$\varepsilon_g^\star$	ε_r
1	39.32	0.61	58.01	0.01	0.06	1.99
4	41.19	0.83	55.73	0.01	0.06	2.18
8	41.67	0.86	55.28	0.01	0.06	2.12
20	42.25	0.90	54.78	0.02	0.06	1.99
40	42.56	0.92	54.51	0.02	0.05	1.94

Table 11: Moments

	Actual	FER	UERP	EMU
σ_y	1.06	1.06	1.07	0.90
$\sigma_{y^\star}$	1.36	1.01	1.03	1.28
σ_c	0.88	1.17	1.33	1.05
$\sigma_{c^\star}$	1.27	2.64	1.61	1.32
σ_π	0.36	1.90	2.92	1.99
$\sigma_{\pi^\star}$	0.24	3.08	2.88	1.93
$\text{corr}(y, y^\star)$	0.59	0.48	0.07	0.18
$\text{corr}(c, c^\star)$	0.42	0.21	0.70	0.70
$\text{corr}(\pi, \pi^\star)$	0.57	0.00	0.87	0.83

Table 12: Moments

	σ_y	σ_c	σ_π
UERP/FER (%)	0.94	13.68	53.68
EMU/FER (%)	-15.09	-10.26	4.74
	$\sigma_{y^\star}$	$\sigma_{c^\star}$	$\sigma_{\pi^\star}$
UERP/FER (%)	1.98	-39.02	-6.49
EMU/FER (%)	26.73	-50.00	-37.34
	FER	UERP	EMU
$\text{corr}(y, y^\star)$	0.48	0.07	0.18
$\text{corr}(c, c^\star)$	0.21	0.70	0.70
$\text{corr}(\pi, \pi^\star)$	0.00	0.87	0.83

but it made French inflation much more volatile. EMU, on the other hand, is good news for France at both the output and inflation front. It is also good news for German inflation variability but bad for German output stability. What lies behind these results is the increase in the importance of supply factors (specially German) under EMU combined with the fact that ECB monetary policy is more procyclical than that in Germany and less procyclical than that in France. Procyclicality in monetary policy tends to stabilize prices but it destabilizes output.

Note also that the synchronization of business cycle across the two countries becomes weaker under both the fixed and the single currency systems (because of the negative international transmission). On the other hand, consumption and inflation correlations grow significantly.

6 Conclusions

In this paper we have set two objectives. First to study the patterns of international transmission of the business cycle under alternative exchange rate systems. And second, to evaluate the implications of recent European Union monetary arrangements (the EMS and the EMU) for macroeconomic volatility.

The European Union has embarked on a path of monetary union. While this has often been interpreted as a political move, economists have attempted to justify the formation of a single currency area by using the theory of optimum currency areas. In this paper, we have offered evidence that this justification may be weaker than previously thought.

Three results stand out concerning the evaluation of EMU. First, France experiences smaller and Germany greater output volatility in comparison to a flexible regime (the reverse pattern obtains for inflation variability).

Second, the ECB is likely to be the arena of intra–EU conflicts because of two reasons. First, country specific supply shocks (which are a major source of volatility) induce significant, negative comovements in economic activity across countries. Such asymmetric behavior will pose policy dilemmas. And second, the increase in the relative importance of supply shocks - at the expense of money shocks - will complicate the conduct of monetary policy because the EURO zone will face a trade off between variability in economic activity and inflation.

And third, we find that the commonly made claim that France will be less susceptible to German macroeconomic influences when she moves from a unilateral peg to a common currency system, is only partially true. Namely, it is valid for inflation but not output developments. The disproportionate influence of German factors on French economic activity survives the move to a more "balanced" monetary arrangement (the EMU).

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— Appendix —

A First order conditions

This section derives the first order conditions associated with the maximization problems described in the text.

A.1 Domestic Household

The problem of the foreign household is given by

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, 1-h_t)$$

subject to

$$\int_S \left[q_t(s')B_{1t+1}(s') + e_t q_t^\star(s')B_{2t+1}(s')\right] \mathrm{d}s' + M_{t+1} + D_{1t+1} + e_t D_{2t+1} \leqslant M_t + N_t + B_{1t} + e_t B_{2t}$$
$$+R_{t-1}D_{1t} + e_t R_{t-1}^\star D_{2t} + W_t h_t + z_t K_t - P_t C_t - P_t I_t - P_t T_t$$
$$P_t C_t \leqslant M_t$$
$$K_{t+1} = \Phi\left(\frac{I_t}{K_t}\right) K_t + (1-\delta)K_t$$

The optimal behavior of the domestic household is given by the system of equations

$$\Lambda_{bt} = \beta E_t \frac{1}{P_{t+1}} U_c\left(\frac{M_{t+1}}{P_{t+1}}, 1-h_{t+1}\right) \tag{22}$$

$$\Phi'\left(\frac{I_t}{K_t}\right)\Lambda_{kt} = P_t \Lambda_{bt} \tag{23}$$

$$\Lambda_{kt} = \beta E_t \left[\Lambda_{bt+1} z_{t+1} + \Lambda_{kt+1}\left(\Phi\left(\frac{I_{t+1}}{K_{t+1}}\right) - \frac{I_{t+1}}{K_{t+1}}\Phi'\left(\frac{I_{t+1}}{K_{t+1}}\right) + 1 - \delta\right)\right] \tag{24}$$

$$q_t(s')\Lambda_{bt} = \beta \Lambda_{bt+1} f(s'|s_t) \tag{25}$$

$$e_t q_t^\star(s')\Lambda_{bt} = \beta \Lambda_{bt+1} e_{t+1} f(s'|s_t) \tag{26}$$

$$\Lambda_{bt} = \beta R_t E_t \Lambda_{bt+1} \tag{27}$$

$$e_t \Lambda_{bt} = \beta R_t^\star E_t e_{t+1} \Lambda_{bt+1} \tag{28}$$

where Λ_{bt} and Λ_{kt} are the Lagrange multipliers associated with the budget constraint and the law of motion of capital respectively. $f(s'|s_t)$ denotes the density function of the state in period $t+1$, s' conditional on the realization of the exogenous processes in period t.

>From (27) and (28), we get the uncovered nominal interest rate parity

$$R_t = R_t^{\star} E_t \frac{e_{t+1}}{e_t} \tag{29}$$

A.2 Domestic firms

The problem of the domestic intermediate firm is

$$\max_{h_t, K_t} P_{1t} Y_t - W_t h_t - z_t K_t$$

while that of the final good producing firm is

$$\min_{Y_{1t}, Y_{2t}} P_t Q_t - P_{1t} Y_{1t} - e_t P_{2t}^{\star} Y_{2t}$$

subject to

$$Q_t = \left(\omega^{1-\rho} {Y_{1t}}^{\rho} + (1-\omega)^{1-\rho} Y_{2t}^{\rho}\right)^{1/\rho}$$

The optimal behavior of firms is described by the set of first order conditions

$$z_t K_t = \alpha P_{1t} Y_t \tag{30}$$

$$W_t h_t = (1-\alpha) P_{1t} Y_t \tag{31}$$

$$Y_{1t} = \left(\frac{P_{1t}}{P_t}\right)^{\frac{1}{\rho-1}} \omega Q_t \tag{32}$$

$$Y_{2t} = \left(\frac{e_t P_{2t}^{\star}}{P_t}\right)^{\frac{1}{\rho-1}} (1-\omega) Q_t \tag{33}$$

where P_t is the aggregate price index, given by

$$P_t = \left(\omega P_{1t}^{\frac{\rho}{\rho-1}} + (1-\omega)(e_t P_{2t}^{\star})^{\frac{\rho}{\rho-1}}\right)^{\frac{\rho-1}{\rho}} \tag{34}$$

A.3 Foreign Household

The problem of the foreign household is given by

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t^{\star}, 1-h_t^{\star}) \tag{35}$$

subject to

$$\int_S \left[\frac{q_t(s')}{e_t} B^\star_{1t+1}(s') + q^\star_t(s') B^\star_{2t+1}(s')\right] \mathrm{d}s' + M^\star_{t+1} + \frac{D^\star_{1t+1}}{e_t} + D^\star_{2t+1} \leqslant M^\star_t + N^\star_t + \frac{B^\star_{1t}}{e_t} + B^\star_{2t}$$
$$+R_{t-1}\frac{D^\star_{1t}}{e_t} + R^\star_{t-1} D_{2t} + W^\star_t h^\star_t + z^\star_t K^\star_t - P^\star_t C^\star_t - P^\star_t I^\star_t - P^\star_t T^\star_t$$
$$P^\star_t C^\star_t \leqslant M^\star_t$$
$$K^\star_{t+1} = \Phi\left(\frac{I^\star_t}{K^\star_t}\right) K^\star_t + (1-\delta) K^\star_t$$

The system of first order conditions defining the optimal behavior of the foreign household are given by the system

$$\Lambda^\star_{bt} = \beta E_t \frac{1}{P^\star_{t+1}} U_c \left(\frac{M^\star_{t+1}}{P^\star_{t+1}}, 1 - h^\star_{t+1}\right) \tag{36}$$

$$\Phi'\left(\frac{I^\star_t}{K^\star_t}\right) \Lambda^\star_{kt} = P^\star_t \Lambda^\star_{bt} \tag{37}$$

$$\Lambda^\star_{kt} = \beta E_t \left[\Lambda^\star_{bt+1} z^\star_{t+1} + \Lambda^\star_{kt+1}\left(\Phi\left(\frac{I^\star_{t+1}}{K^\star_{t+1}}\right) - \frac{I^\star_{t+1}}{K^\star_{t+1}} \Phi'\left(\frac{I^\star_{t+1}}{K^\star_{t+1}}\right) + 1 - \delta\right)\right] \tag{38}$$

$$\frac{q_t(s')}{e_t} \Lambda^\star_{bt} = \beta \frac{\Lambda^\star_{bt+1}}{e_{t+1}} f(s'|s_t) \tag{39}$$

$$q^\star_t(s') \Lambda^\star_{bt} = \beta \Lambda^\star_{bt+1} f(s'|s_t) \tag{40}$$

$$\frac{\Lambda^\star_{bt}}{e_t} = \beta R_t E_t \frac{\Lambda^\star_{bt+1}}{e_{t+1}} \tag{41}$$

$$\Lambda^\star_{bt} = \beta R^\star_t E_t \Lambda^\star_{bt+1} \tag{42}$$

where $\Lambda^\star_{bt}$ and $\Lambda^\star_{kt}$ are the Lagrange multipliers associated with the budget constraint and the law of motion of capital. $f(s'|s_t)$ denotes the density function of s' conditional on the realization of the exogenous processes in period t.

It is worth noting that (39) and (40) together with (25) and (26) lead to

$$e_t \Lambda_{bt} \propto \Lambda^\star_{bt} \tag{43}$$

A.4 Foreign firms

The problem of the foreign intermediate firm is

$$\max_{h^\star_t, K^\star_t} P^\star_{2t} Y^\star_t - W^\star_t h^\star_t - z^\star_t K^\star_t$$

and of the final good firm

$$\min_{Y^\star_{1t}, Y^\star_{2t}} P^\star_t Q^\star_t - \frac{P_{1t}}{e_t} Y^\star_{1t} - P^\star_{2t} Y^\star_{2t}$$

subject to

$$Q_t^\star = \left(\omega^{1-\rho} Y_{2t}^{\star\rho} + (1-\omega)^{1-\rho} Y_{1t}^{\star\rho}\right)^{1/\rho}$$

The optimal behavior of firms is described by the set of first order conditions

$$z_t^\star K_t^\star = \alpha P_{2t}^\star Y_t^\star \tag{44}$$

$$W_t h_t = (1-\alpha) Y_t \tag{45}$$

$$Y_{2t}^\star = \left(\frac{P_{2t}^\star}{P_t^\star}\right)^{\frac{1}{\rho-1}} \omega Q_t^\star \tag{46}$$

$$Y_{1t}^\star = \left(\frac{P_{1t}}{e_t P_t^\star}\right)^{\frac{1}{\rho-1}} (1-\omega) Q_t^\star \tag{47}$$

where $P_t^\star$ is the aggregate price index, given by

$$P_t^\star = \left(\omega P_{2t}^{\star\,\frac{\rho}{\rho-1}} + (1-\omega)\left(\frac{P_{1t}}{e_t}\right)^{\frac{\rho}{\rho-1}}\right)^{\frac{\rho-1}{\rho}} \tag{48}$$

A.5 Specific equilibrium conditions

Equilibrium in the final good markets is given by

$$Q_t = C_t + I_t + G_t \tag{49}$$

$$Q_t^\star = C_t^\star + I_t^\star + G_t^\star \tag{50}$$

and in the intermediate goods markets.

$$Y_t = Y_{1t} + Y_{1t}^\star \tag{51}$$

$$Y_t^\star = Y_{2t} + Y_{2t}^\star \tag{52}$$

The market clearing conditions in the financial markets are given by

$$\int_S \left[q_t(s')\left(B_{1t+1}(s') + B_{1t+1}^\star(s')\right) + e_t q_t^\star(s')\left(B_{2t+1}(s') + B_{2t+1}^\star(s')\right)\right] s' = 0 \tag{53}$$

together with

$$D_{1t} + D_{1t}^\star = 0 \tag{54}$$

$$D_{2t} + D_{2t}^\star = 0 \tag{55}$$

B Solving the model

Each variable is detrended as follows: Each real variable is divided by Γ_t while each nominal variable is deflated by the domestic stock of money. For instance, $x_t = X_t/\Gamma_t$ for $x \in \{c, c^\star, i, i^\star, k, k^\star, y, y^\star, \{y_j, y_j^\star\}_{i=1,2}, q, q^\star\}$ and $p_1 = P_1/M_t$, $p_2 = eP^\star/M$, $p = P/M$, $p^\star = eP^\star/M$, $m^\star = e_{-1}M^\star/M$, $\lambda_b = \Lambda_b M$, $\lambda_b^\star = \Lambda_b^\star M/e$, $w = W/M$ and $w^\star = e_{-1}W^\star/M$.

The model is then log–linearized around its deterministic steady state. The linear rational expectations dynamic system is then solved using the method described in Farmer (1993).