Asymmetric Shocks and Monetary Policy in a Currency Union

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Abstract

We analyze the conduct of monetary policy in a currency union in the face of asymmetric shocks. In particular, we compare the stabilization properties of a currency union versus alternative exchange rate arrangements and show how the relative performance of a currency union depends on the extent of economic integration in patterns of consumption and production and on the relative weights placed on price stability versus employment stability in the monetary authority's objective function. Keywords: monetary union, stabilization.

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Section I: Introduction

The conduct of monetary stabilization policy in a currency union has not received much research attention.[1] This is surprising, given that an understanding of this issue is highly relevant in comparing a currency union to alternative exchange rate arrangements. Although comparing the stabilization properties of fixed and flexible exchange rate systems is an activity with a long tradition in international macroeconomics, the option of a currency union has not been formally analyzed in this literature. In recent years, the instability of fixed exchange rate systems has suggested the possibility that the only viable long-term options for a country are a floating exchange rate or participation in a currency union (Obstfeld 1995, Obstfeld and Rogoff 1995, Persson and Tabellini 1995). If this is the case, it is important to gain a greater understanding of the monetary stabilization properties of a currency union.

In this paper, our focus is on the stabilization problem of adjustment in response to asymmetric shocks. Asymmetric shocks arguably have been the impulse behind the collapse of most fixed exchange rate systems. The need to finance the Vietnam war in part motivated the US monetary expansion that triggered the collapse of the Bretton Woods system; the German reunification shock ultimately forced the exit of Britain and Italy from the ERM in 1992 and a sharp widening of the fluctuation bands for the remaining members in 1993. Indeed, empirical attempts to

[1] But see Alesina and Grilli (1992) for a reduced-form model. Other aspects of monetary policy, especially setting the operational goal (an inflation target versus a money target), have been more extensively studied.

evaluate the suitability of various regions for currency unions have focused on the prevalence of asymmetric shocks as a key indicator of whether a region qualifies as an optimal currency area (see Bayoumi and Eichengreen 1992).

We consider only monetary policy as a stabilization tool. By adopting this strategy, we ignore alternative potential stabilization policies such as fiscal transfers and encouraging intra-union labor mobility. By ruling out non-monetary stabilization policies, this means our analysis will establish a lower bound to the stabilization potential of a currency union.

The model developed in this paper is a standard two-country monetary model, as employed by Canzoneri and Henderson (1985, 1991).[2] Although, Canzoneri and Henderson employed this framework to compare the stabilization properties of alternative exchange rate systems, they did not consider the currency union case. Accordingly, the main contribution of this paper is to extend the analysis of monetary stabilization policy to incorporate the currency union case. In addition, Canzoneri and Henderson consider only a common productivity shock and an asymmetric demand shock. Our approach is more general in that we also allow for velocity shocks and permit disturbances to be common, national (i.e. country-specific) or asymmetric.

In terms of stabilization policy, the key characteristic of a cur-

[2] Buiter, Corsetti and Pesenti (1995) write a multi-country core-periphery version of the model. In what follows, we focus on the standard two-country case but it would clearly be of interest to extend the analysis to a multi-country framework. Persson and Tabellini (1995) lay out a generalized approach to analyzing interdependence issues.

rency union is that the union-wide money supply can be targeted but that the allocation of money across countries within the union cannot. We assume the currency union's monetary authority sets monetary policy to minimize the weighted sum of the loss functions of the monetary authorities of the member countries. We show that it turns out that the best response of the monetary authority of a currency union to asymmetric demand shocks is to leave unchanged the union-wide money supply, or "do nothing". This policy generates inefficiently large fluctuations in output and inflation in the member countries, even if union-wide aggregate output and inflation display zero volatility. However, monetary policy in a currency union does respond to aggregate productivity shocks, even if the shock is not equally large in both regions, and it is this responsiveness that distinguishes a currency union from a symmetric fixed exchange rate arrangement. Given the model's structure, there is no need to respond to aggregate demand shocks, since these are absorbed by adjustment in the real interest rate without any change in employment or price levels. Moreover, velocity shocks do not pose a stabilization problem, since it is optimal and feasible to fully accommodate velocity shocks in all the regimes we consider.

In addition to these analytical results, we quantitatively compare stabilization performance, as measured by the loss functions of the monetary authorities, in a currency union in response to various shocks versus alternative exchange rate arrangements. A quantitative approach has the virtue of measuring relative performance across regimes. This allows us to gain insight into whether the regime choice "matters" in any substantive way for stabilization performance. Moreover, such an exercise is important in order to understand how changes in key parameters affect the attractiveness of a currency union, relative to other exchange rate arrangements. For instance, it is of interest to know the effects of greater economic integration on the relative desirability of a currency union in terms of stabilization performance.

The structure of the rest of the paper is as follows. In section 2, the model is laid out. The structure is adapted from Canzoneri and Henderson (1991), so the presentation of the basic details will be relatively brief.[3] As a prelude to the analysis of a currency union, we analyze optimal monetary policy under alternative exchange rate arrangements in section 3. In section 4, monetary policy in a currency union is studied. Section 5 develops the comparative results on stabilization performance. Section 6 concludes.

Section II: The Model

A: Basic Structure

In this section, we describe the basic structure of the model world economy. All variables, except for interest rates, are in logs and are expressed as deviations from a no-shock equilibrium. Home and foreign supply schedules are given by

[3] Canzoneri and Henderson (1991) analyze a common productivity shock and an asymmetric shock. Our approach is more general in that we also consider velocity disturbances and allow shocks to be common, country-specific or asymmetric.

$$y = (1 - \alpha)n + a; \quad y^* = (1 - \alpha)n^* + a^* \qquad \alpha \in (0,1) \tag{1}$$

where y, y^* are home and foreign levels of output, n, n^* are home and foreign levels of employment and a, a^* are home and foreign productivity shocks with mean zero and finite variance. The assumption of diminishing returns to labor implies labor demand schedules are negatively sloped

$$w - p = a - \alpha n; \quad w^* - p^* = a^* - \alpha n^* \tag{2}$$

where w, w^* are home and foreign wage rates and p, p^* are home and foreign output prices. Output demands are a function of relative prices, the real interest rate and a stochastic term

$$y = \delta z - vr + \lambda; \quad y^* = -\delta z - vr^* + \lambda^* \qquad \delta, v > 0 \tag{3}$$

where z is the real exchange rate, r, r^* are the home and foreign real interest rates and λ, λ^* represent demand shocks for home and foreign goods respectively. The parameter δ can be interpreted as indexing the degree of substitutability between home and foreign goods: a large value of δ means that relative demands are highly sensitive to relative prices, indicating that home and foreign products are good substitutes.

The real exchange rate z is defined as the relative price of the foreign good in terms of the domestic good, in units of the domestic currency. Let s be the number of domestic currency units per unit of foreign currency. Then

$$z \equiv p^* + s - p \tag{4}$$

The real interest rate equals the nominal interest rate minus the expected rate of inflation. If q, q^* are the home and foreign consumer price levels, the home and foreign real interest rates are

$$r = i - (Eq_{+1} - q); \quad r^* = i^* - (Eq^*_{+1} - q^*) \tag{5}$$

where E denotes the expectations operator and i, i^* are the home and foreign nominal interest rates. These are linked by uncovered interest rate parity

$$i = i^* + Es_{+1} - s \tag{6}$$

Let β be the share of foreign (home) goods in home (foreign) consumption. Then the home and foreign consumer price inflation rates q, q^* are given by

$$q = (1 - \beta)p + \beta(p^* + s) = p + \beta z; \quad q^* = (1 - \beta)(p^* + s) + \beta p = p^* - \beta z \tag{7}$$

We restrict the value of β to lie in the interval $0 < \beta < 1/2$, which implies a home bias in consumption. Finally, only domestic residents hold domestic money.[4] Money demand is assumed to be proportional to income so that monetary equilibrium requires that

$$m = \kappa + p + y = \kappa + w + n; \quad m^* = \kappa^* + p^* + y^* = \kappa^* + w^* + n^* \tag{8}$$

where κ, κ^* are velocity shocks.

In order to allow for a stabilization role for monetary policy, we

[4] For instance, this could be the result of a legal restriction requiring the use of domestic currency for domestic transactions.

Table 1: Key Parameters

π	$\frac{1-\alpha}{2\delta+v(1-2\beta)}$	υ_0	$\frac{\sigma\alpha}{1+\sigma\alpha^2}$
ϕ_0	$\frac{\sigma[\alpha+\beta(1-\alpha)\pi]\beta(1-\alpha)\pi}{1+\sigma[\alpha+\beta(1-\alpha)\pi]^2}$	υ_1	$\frac{\beta\sigma\alpha[(1-\alpha)\pi\gamma_0-\pi]}{1+\sigma\alpha^2}$
ϕ_1	$\frac{\sigma[\alpha+\beta(1-\alpha)\pi]}{1+\sigma[\alpha+\beta(1-\alpha)\pi]^2}$	υ_2	$\frac{\beta\sigma\alpha[(1-\alpha)\pi\gamma_1+\pi]}{1+\sigma\alpha^2}$
ϕ_2	$\frac{\sigma[\alpha+\beta(1-\alpha)\pi]\beta\pi}{1+\sigma[\alpha+\beta(1-\alpha)\pi]^2}$	χ_0	$\frac{\sigma\alpha}{1+\sigma\alpha^2}$
γ_0	$\frac{\pi}{\alpha+(1-\alpha)\pi}$	χ_1	$\frac{\sigma[\alpha+2\beta(1-\alpha)\pi](1-2\beta\pi)}{1+\sigma[\alpha+2\beta(1-\alpha)\pi]^2}$
γ_1	$\frac{1-\pi}{\alpha+(1-\alpha)\pi}$	χ_2	$\frac{\sigma[\alpha+2\beta(1-\alpha)\pi]2\beta\pi}{1+\sigma[\alpha+2\beta(1-\alpha)\pi]^2}$
Ψ	$\frac{\sigma\alpha}{1+\sigma\alpha^2}$		

assume that wages are determined one period in advance. Since no shocks are anticipated, labor unions set $w = 0$ and employment fluctuations are driven by monetary surprises

$$n = m - \kappa; \quad n^* = m^* - \kappa^* \tag{9}$$

In words, a positive domestic (foreign) monetary surprise raises domestic (foreign) employment. In contrast, anticipated changes in the money supply have zero impact on real variables, in the presence of forward-looking wage-setters. Using [4] [5] and [6] and imposing a no-bubble terminal condition as a boundary restriction, we can write the real exchange rate as

$$z = (1-\alpha)\pi(n-n^*) + \pi(a-a^*) - \pi(\lambda-\lambda^*) \tag{10}$$

where π is defined in Table 1.

Finally, from [2] and [10], we can write the home and foreign consumer price levels as

$$q = \alpha n - a + \beta z; \quad q^* = \alpha n^* - a^* - \beta z \tag{11}$$

The dependence of the consumer price level on the real exchange rate means that it cannot be perfectly controlled by the domestic monetary authority alone. This sensitivity of the domestic price level to foreign output constitutes the key international spillover effect in the model. This externality underlies the inefficiency of uncoordinated monetary policies.

Finally, the nominal exchange rate is determined by

$$s = p - p^* + z = [\alpha + (1 - \alpha)\pi](n - n^*) - \pi(\lambda - \lambda^*) - (1 - \pi)(a - a^*) \tag{12}$$

This completes the description of the model's structure. We now turn to the determination of monetary policy.

B: Monetary Policy

The home and foreign monetary authorities wish to minimize respectively

$$l = \frac{1}{2}\left[n^2 + \sigma q^2\right]; \quad l^* = \frac{1}{2}\left[n^{*2} + \sigma q^{*2}\right] \tag{13}$$

That is to say, the monetary authority dislikes variance in employment and price levels, with a relative weight on price stability of σ. This specification is standard in the monetary stabilization literature. Notice that it is straightforward in the model to perfectly stabilize employment. All the monetary authority needs to do is to guarantee a perfectly predictable path for the money supply.[5] However, keeping employment fixed would make the monetary authority unable to offset the inflation effects of demand shocks by inducing countervailing movements in employment.

The loss functions given in [13] do not contain an inflation bias in that the monetary authority wishes to stabilize (log) employment around its steady-state value of zero. This is in contrast to the inflation-determination literature initiated by Barro and Gordon (1983), in which the market-determined level of output is perceived as too low by policymakers. In the presence of an inflation bias, Rogoff (1985a) shows that international monetary coordination can increase the steady-state rate of inflation by eliminating real depreciation as a consequence of monetary expansion and hence lowering the costs of inflation to the policymaker. We rule out this effect in order to focus more clearly on the issue of stabilization in response to asymmetric disturbances: in the no-shock case, the monetary authority would opt for a perfectly stable price level. We can rewrite [13] as

$$
\begin{aligned}
l \;=\; & \frac{1}{2}[(m - \kappa)^2 \\
& +\sigma((\alpha+\beta(1-\alpha)\pi)(m-\kappa) - \beta(1-\alpha)\pi n^{*} - a \\
& +\beta\pi(a-a^{*}) - \beta\pi(\lambda-\lambda^{*}))^2]
\end{aligned}
\tag{14}
$$

$$
\begin{aligned}
l^{*} \;=\; & \frac{1}{2}[(m^{*} - \kappa^{*})^2 \\
& +\sigma((\alpha+\beta(1-\alpha)\pi)(m^{*}-\kappa^{*}) - \beta(1-\alpha)\pi n - a^{*} \\
& -\beta\pi(a-a^{*}) + \beta\pi(\lambda-\lambda^{*}))^2]
\end{aligned}
\tag{15}
$$

[5] A stable money supply fixes employment only if velocity is constant. We discuss velocity shocks later in this subsection.

Notice that it is automatic that optimal monetary policies will fully accommodate velocity shocks, since this achieves employment stabilization without sacrificing price stability. For this reason, in what follows we ignore velocity disturbances and treat the monetary authority as being able to perfectly control employment ($n = m - \kappa$). Of course, velocity shocks are a potentially important source of fluctuations under a money-targeting rule or if it is difficult to quickly identify the occurrence of a velocity disturbance. However, a money-targeting rule is not generally optimal and so falls outside the scope of this paper and we assume full information on the part of the monetary authorities about the identity of shocks.

In section 3, as a prelude to the analysis of a currency union, we consider different types of exchange rate arrangements. This is done in order to provide comparators for the relative performance evaluations in section 5 and to illustrate the relationship between the stabilization properties of a currency union and more familiar types of exchange rate systems.

First, we examine a flexible exchange rate system. Next, we turn to the analysis of fixed exchange rate arrangements. Finally, in this section, we consider a cooperative regime in which national monetary policies are chosen to maximize global welfare. In each case, we present the solution to the decision problem of the monetary authority, which determines the output and inflation effects of asymmetric shocks. In section 4, we study the operation of a currency union in a similar fashion.

Section III: Alternative Exchange Rate Systems

In analyzing adjustment to shocks under various exchange rate regimes, we follow the Aoki (1981) solution method by which the global shift in employment $(n+n^*)$ and the asymmetric shift $(n-n^*)$ are derived. In combination, these two expressions determine n and n^* and q and q^* are easily obtained from [11] once n and n^* are known.

A: Floating Exchange Rate Regime

In a floating exchange rate regime, the home and foreign monetary authorities choose their policies independently. Optimization yields the monetary policies

$$n=\phi_0 n^*+\phi_1 a+\phi_2(\lambda-\lambda^*)-\phi_2(a-a^*);\quad n^*=\phi_0 n+\phi_1 a^*-\phi_2(\lambda-\lambda^*)+\phi_2(a-a^*) \tag{16}$$

where ϕ_0, ϕ_1 and ϕ_2 are given in Table 1. From [16] we can write

$$n-n^* = \frac{\phi_1-2\phi_2}{1+\phi_0}(a-a^*)+\frac{2\phi_2}{1+\phi_0}(\lambda-\lambda^*) \tag{17}$$

$$n+n^* = \frac{\phi_1}{1-\phi_0}(a+a^*) \tag{18}$$

Notice that aggregate world employment $(n+n^*)$ responds only to aggregate productivity shocks; aggregate demand shocks are rather fully absorbed by adjustment in real interest rates (see Lane 1996). These equations imply that home and foreign employment are determined by

$$n = \frac{1}{2}\frac{\phi_1}{1-\phi_0}(a+a^*)+\frac{1}{2}\frac{\phi_1-2\phi_2}{1+\phi_0}(a-a^*)+\frac{\phi_2}{1+\phi_0}(\lambda-\lambda^*) \tag{19}$$

$$n^{*} = \frac{1}{2}\frac{\phi_1}{1-\phi_0}(a+a^{*}) - \frac{1}{2}\frac{\phi_1 - 2\phi_2}{1+\phi_0}(a-a^{*}) - \frac{\phi_2}{1+\phi_0}(\lambda - \lambda^{*}) \quad (20)$$

at is to say, in the floating exchange rate equilibrium, domestic monetary expansion and foreign monetary contraction causes home employment to increase in response to a positive shock but foreign employment to contract. The intuition is that the domestic monetary authority increases domestic output in order to offset the deflationary impact of real appreciation on the domestic price level; symmetrically, the foreign monetary authority contracts foreign output in order to offset the inflationary impact of real depreciation on the foreign price level.

B: Fixed Exchange Rate Regime

We consider two types of pegged exchange rate system. In an asymmetric fix, the leader country chooses its monetary policy autonomously in the knowledge that the follower country will respond by adjusting its monetary policy in order to maintain the nominal exchange rate peg. We can think of the US during the Bretton Woods system and Germany in the EMS as playing the role of leader. In a symmetric fix, in contrast, each country adjusts equally in order to maintain the peg: this is akin to the system outlined by McKinnon (1984).

0.0.1 Asymmetric Fix

We assume without loss of generality that the home country is the leader country. In the home-leadership case, from [12] the nominal exchange rate commitment $s = 0$ implies the rule for foreign monetary policy

$$n^* = n - \gamma_0(\lambda - \lambda^*) - \gamma_1(a - a^*) \tag{21}$$

where γ_0 and γ_1 are shown in Table 1. The home monetary authority incorporates the reaction function [21] into its optimization problem. The solution is

$$n = \nu_0 a - v_1(\lambda - \lambda^*) - v_2(a - a^*) \tag{22}$$

$$n^* = v_0 a - (v_1 + \gamma_0)(\lambda - \lambda^*) - (v_2 + \gamma_1)(a - a^*) \tag{23}$$

where v_0, v_1 and v_2 are shown in Table 1. Notice that in this case, the domestic productivity shock a is in effect the "aggregate" shock since the home (leader) country is not directly concerned with the impact of foreign productivity shocks. Second, the home monetary authority minimizes the response of domestic employment to asymmetric shocks by shifting the burden of adjustment onto foreign employment.

0.0.2 Symmetric Fix

In a symmetric fix, each country takes equal responsibility for maintaining the fixed nominal exchange rate. Equal responsibility means that the adjustment burden is shared, such that $n^* = -n$. In combination with [12] this gives

$$n = \frac{1}{2}\gamma_0(\lambda - \lambda^*) + \frac{1}{2}\gamma_1(a - a^*) \tag{24}$$

$$n^* = -\frac{1}{2}\gamma_0(\lambda - \lambda^*) - \frac{1}{2}\gamma_1(a - a^*) \tag{25}$$

In this case, home and foreign employment do not respond to aggregate shocks, since monetary policies are entirely dedicated to maintaining the fixed nominal exchange rate.

C: Cooperation

In a cooperative regime, each monetary authority internalizes the impact of its policies on the welfare of the other country. In other words, policies are chosen such that

$$\frac{\partial l}{\partial n} + \frac{\partial l^*}{\partial n} = 0; \quad \frac{\partial l}{\partial n^*} + \frac{\partial l^*}{\partial n^*} = 0$$

Following similar solution techniques to the previous cases, we obtain

$$n + n^* = \chi_0 (a + a^*) \tag{26}$$

$$n - n^* = \chi_1 (\lambda - \lambda^*) + \chi_2 (a - a^*) \tag{27}$$

where χ_0, χ_1 and χ_2 are in Table 1. It follows that

$$n = \frac{1}{2}\chi_0 (a + a^*) + \frac{1}{2}\chi_1 (\lambda - \lambda^*) + \frac{1}{2}\chi_2 (a - a^*) \tag{28}$$

$$n^* = \frac{1}{2}\chi_0 (a + a^*) - \frac{1}{2}\chi_1 (\lambda - \lambda^*) - \frac{1}{2}\chi_2 (a - a^*) \tag{29}$$

The presentation of alternative exchange rate arrangements is now complete. In the next section, we turn to the currency union case.

Section IV: Currency Union

By its definition, there is but a single monetary policy for a currency union.[6] We assume the monetary authority of the currency union cares equally about the home and foreign countries: this is a natural as-

[6] See Lane (1996) for more details about the derivation of this case.

sumption and could be generated, for example, by a central bank board with representatives from each member country that bargained over monetary policy decisions.[7] Accordingly, it chooses m^{cu} to minimize the loss function[8]

$$l^{cu} = (l + l^*) = \frac{1}{2}\left(n^2 + n^{*2} + \sigma[q^2 + q^{*2}]\right) \quad (30)$$

Home and foreign employment are linked together by the real exchange rate equation [10] and the monetary equilibrium condition

$$m^{cu} = n + n^* + \quad (31)$$

where $= \kappa + \kappa^*$ is the aggregate velocity shock. The monetary authority recognizes that it can only affect aggregate employment and not the distribution of employment between the home and foreign countries. Accordingly, it recognizes that $(n - n^*)$ is implicitly given by [21].[9] In turn, [21] and [31] imply that n and n^* are determined by

$$n = m^{cu} - \;/2 + \Gamma/2 \quad (32)$$

$$n^* = m^{cu} - \;/2 - \Gamma/2 \quad (33)$$

[7] In this respect, the objective function of the currency union's monetary authority resembles that in the cooperative arrangement. However, in the cooperative arrangement, two instruments are available to the policymakers: the money supplies of the two member countries. In contrast, the currency union's monetary authority has available to it just one policy instrument: a single union-wide money supply.

[8] It is straightforward to show that the same results are obtained when the monetary union cares only about average employment and average inflation in the currency union. In this case the loss function would be $l^{cu} = 1/2\left((n_{t+}n_{t^*})^2 + \sigma(q + q^*)^2\right)$.

[9] This equation is derived from the real exchange rate equation [3.6] and the fact that the real exchange rate in a currency union (or under a peg) is just $z = p^* - p = \alpha(n - n^*) - (a - a^*)$.

where

$$\Gamma \equiv \gamma_0(\lambda - \lambda^*) + \gamma_1(a - a^*)$$

Equations [32]–[33] are obtained from the two relationships that link home and foreign employment: the real exchange rate equation [10] and the monetary equilibrium condition [31]. Replacing [31], [32] and [33] into [30] we obtain

$$l^{cu} = \begin{array}{c} 1/2\,\{(m^{cu} - \;\;/2 + \Gamma/2)^2 + (m^{cu} - \;\;/2 - \Gamma/2)^2 + \\ \sigma(\alpha m^{cu} - \alpha \;\; + \alpha\Gamma/2 - a + \beta z)^2 + \sigma(\alpha m^{cu} - \alpha \;\; - \alpha\Gamma/2 - a^* - \beta z)^2\} \end{array} \tag{34}$$

It is straightforward to work out that the solution to this minimization problem is

$$m^{cu} = \;\; + \Psi(a + a^*) \tag{35}$$

where Ψ is in Table 1. In words, optimal monetary policy in a currency union fully accommodates velocity shocks ($\neq 0$) and also responds to aggregate productivity shocks ($a + a^* \neq 0$). From [31], the deviation in aggregate employment is given by the size of the monetary expansion (net of velocity shocks)

$$n + n^* = \Psi(a + a^*) \tag{36}$$

In essence, the monetary authority acts as if it cares only about aggregate fluctuations, even though the members of the currency union also care about local shocks. A result of this type is implicit in the reduced form analysis of Alesina and Grilli (1991). Again, monetary policy responds only to aggregate productivity shocks since aggregate demand shocks are fully absorbed by adjustment in the real interest rate.

From [21] we can write relative employment as

$$n - n^{*} = \gamma_0(\lambda - \lambda^{*}) + \gamma_1(a - a^{*}) \tag{37}$$

Even if monetary policy (and hence aggregate employment) does not respond to purely asymmetric shocks, the composition of employment will change, with a reallocation between home and foreign countries. From [36] and [37] home and foreign employment are

$$n = \frac{\Psi}{2}(a + a^{*}) + \frac{1}{2}\gamma_0(\lambda - \lambda^{*}) + \frac{1}{2}\gamma_1(a - a^{*}) \tag{38}$$
$$n^{*} = \frac{\Psi}{2}(a + a^{*}) - \frac{1}{2}\gamma_0(\lambda - \lambda^{*}) - \frac{1}{2}\gamma_1(a - a^{*}) \tag{39}$$

Notice that this solution is quite similar to the solution to the symmetric fixed exchange rate case. However, a crucial difference is that home and foreign employment now respond to aggregate productivity shocks: the common monetary authority is able to react to such aggregate disturbances whereas the symmetric fixed exchange rate system precludes adjustment to common shocks. Notice also that the response to a purely symmetric productivity shock ($a = a^{*}$) is exactly the same as under a cooperative regime or an asymmetric fix ($\Psi = \chi_0 = v_0$ in Table 1).

Section V: Relative Performance

Comparing across regimes, the following general results hold. First, a currency union dominates a symmetric fix in terms of its stabilization properties: although both deliver the same outcome in the event of asymmetric shocks, a currency union also provides stabilization in response to common productivity shocks. Second, the flexible exchange rate case typically generates a lower expected loss than under a currency union. This confirms the intuition that flexibility in the exchange rate is helpful in adjusting to shocks. Third, the follower country prefers a currency union to an asymmetric fix but the ranking is reversed for the leader country. Finally, a currency union achieves the same outcome as a cooperative regime in the case of common productivity shocks but otherwise performs worse in terms of stabilization performance.

However, these qualitative results do not indicate the size of the performance gaps between regimes, nor how they vary with changes in key parameters. These considerations are especially important in the context of the decision to form a currency union, as policymakers must weigh relative stabilization performance against other economic and political dimensions of the regime choice and hence require some quantitative guidance.

A: Benchmark Simulations

Using numerical analysis, we compare stabilization performance across regimes in response to various shocks, where the shocks are normalized to be of unit magnitude. We consider both productivity and demand shocks. In each case, we present (i) asymmetric shocks ($a = -a^* = 1;\ or\ \lambda = -\lambda^* = 1$); (ii) idiosyncratic ("national") shocks ($a = 1\ and\ a^* = 0;\ or\ \lambda = 1\ and\ \lambda^* = 0$); and (iii) common shocks ($a = a^* = 1;\ or\ \lambda = \lambda^* = 1$). We initially report results for a benchmark set of parameters. We also examine the sensitivity of relative stabilization

Table 2: Realized Losses

	(a, a^*)			(λ, λ^*)		
	(1,-1)	(1,0)	(1,1)	(1,-1)	(1,0)	(1,1)
	(1)	(2)	(3)	(4)	(5)	(6)
LCU	0.46	1.22	2.36	0.93	0.23	0.00
LFLEX	0.34	0.93	1.83	0.34	0.085	0.00
LLEAD	0.44	1.21	2.36	0.068	0.02	0.00
LFOLL	0.52	1.23	2.36	3.51	0.88	0.00
LSYMM	0.46	1.43	3.00	0.93	0.23	0.00
LCOOP	0.33	1.09	2.36	0.33	0.083	0.00

performance to changes in key parameters in the model. In particular, it is important to consider the effects of greater economic integration on relative performance under different exchange rate arrangements.

The benchmark parameter values for the simulations are as follows. Relative to Taylor (1993), which is a world economy model, we increase β, the share of imports in consumption, from 0.2 to 0.3 and δ, the sensitivity of demand to the real exchange rate, from 0.1 to 0.5 in order to increase the degree of trade integration between the two economies, to better reflect linkages within, say, the European Union. We follow Henderson and McKibbin (1993) in choosing a value of 0.3 for α, which implies a 1 percent increase in output requires a 1.42 percent increase in employment, and by setting $v = 0.5$: a one point increase in the real interest rate decreases demand by 0.5 percentage points. Finally, the monetary authority's relative weight on its price level target is set at $\sigma = 3$, which is the value estimated, using US data, in the recent study by Broadbent and Barro (1997).

Column (1) of Table 2 shows the realized loss functions under a currency union and alternative exchange rate regimes in the case of a pure asymmetric productivity shock: $a = -a^* = 1$. We see that the loss under a currency union is the same as that under a symmetric peg; it is more severe than under flexible exchange rates, the leadership position in an asymmetric fix or in a cooperative system but the currency union does outperform the follower position in an asymmetric fix. However, the range of outcomes across all the regimes is not too variable, indicating that the nominal exchange regime is not too important for adjustment to asymmetric productivity shocks.

A national productivity shock is considered in column (2): $a = 1;\ a = 0$. This case has elements of both an aggregate shock ($a + a^* = a = 1$) and an asymmetric shock ($a - a^* = 1 - 0 = 1$). Here, the currency union does better than a symmetric fix, for the reason that the currency union responds to aggregate productivity disturbances but the symmetric fix regime does not. Since the aggregate shock is the same as the national shock, performance under a currency union is very similar to the leader position in an asymmetric fix. The loss is only slightly larger if the home country is the follower in an asymmetric fix. However, floating exchange rates and cooperation each generate smaller losses than the currency union in this case.

We present results for a common productivity shock ($a = a^* = 1$) in column (3). As was previously mentioned, the currency union exactly matches the performance of the cooperative regime and an asymmetric fix in this case. Note that both leader and follower in an asymmetric fix enjoy the same outcome, since there is no conflict of interest in the case of a common shock. Again, the currency union is inferior to floating but outshines a symmetric fix. Comparing across columns (1)-(3), it is clear that aggregate productivity disturbances generate bigger losses under all regimes than purely asymmetric shocks. The reason is that home and foreign productivity shocks both destabilize the price level in the same direction, augmenting the need for monetary policy intervention.

We turn to demand shocks in columns (4)-(6). Relative performance across regimes is very similar in columns (4) and (5), for the reason that only the asymmetric component of the national demand shock (column (5)) matters, since the aggregate element is absorbed by adjustment in real interest rates. In either case, the currency union significantly outperforms the follower position in an asymmetric fix and is identical to a symmetric fix. Floating and cooperation generate similar losses, which are less than one third the loss under a currency union, and the leader position in an asymmetric fix generates the smallest loss by far. A purely asymmetric demand shock is more costly under all regimes than a national shock, since a positive home shock and a negative foreign shock each moves the price level in the same direction, which is a destabilizing pattern. Finally, from column (6), a common demand shock is fully absorbed in real interest rates and so does not generate a loss, regardless of the monetary arrangements in place.

B: Sensitivity to Parameter Values

In order to make comparisons of the stabilization performances of a currency union and alternative exchange rate regimes, we construct the ratios

$$CUJ = \frac{L^{CU}}{L^{J}} \qquad J = FLEX,\ LEAD,\ FOLL,\ SYMM,\ COOP$$

These ratios express the value of the loss function of the monetary authority under a currency union in proportion to that experienced under alternative arrangements. We examine the effects of varying the "integration" parameters β, δ and σ for the four scenarios of asymmetric, national and common productivity shocks, plus asymmetric demand shocks. It is important to be clear that we analyze the impact of variation in these parameters, conditional on the occurrence of these various types of shocks. In other words, we treat the size and asymmetry of shocks as exogenous. In contrast, Frankel and Rose (1996) treat the international correlation of shocks as endogenous and speculate that greater integration may make shocks more symmetric across members of a currency union. While recognizing the importance of this issue, our focus here, for tractability, is on stabilization performance conditional on the occurrence of various types of shocks.

In Figure 1, we consider the effects on relative performance of varying β, the import share in consumption, over the range $[0.01 - 0.495]$. An increase in β indicates a diminished home bias in consumption patterns, which is one possible dimension of greater economic integration. In the model, an increase in β raises the sensitivity of the price level to the value of the real exchange rate and hence amplifies the spillover between home and foreign monetary policies.

From [22]-[23] and [38]-[39] an increase in β has no impact on the relative performance of a currency union versus an asymmetric fix in the cases of asymmetric, national or common productivity shocks. $CUSYMM$ falls in β in the event of a national productivity shock but is otherwise independent of β. However, $CUFLEX$ is rising in β for all types of productivity shocks but is falling in β in the case of an asymmetric demand shock. $CUCOOP$ behaves similarly to $CUFLEX$, with the exceptions of national and common productivity shocks. In the former case, $CUCOOP$ is non-monotonic in β but converges to unity as the consumption home bias is eliminated; in the latter case, we know that the currency union and cooperative regimes deliver the same outcome in response to a common productivity shock.[10]

The impact of a change in δ, the elasticity of output demand with respect to the real exchange rate, on the relative performance of different regimes is presented in Figure 2, which varies δ over the range $[0.2 - 1.0]$. A high value of δ can be interpreted as implying that the two countries are producing goods that are close substitutes; a low value of δ, that the goods are poor substitutes. The effect of greater integration on δ is ambiguous. If integration causes countries to converge in terms of production structure, δ will increase; if integration fosters greater specialization at a regional

[10] In addition, we know that an asymmetric fix also generates the same outcome in this case. A symmetric fix generates lower welfare but the difference is independent of β. For clarity, we only graph ratios that actually are sensitive to the parameter in question.

level, on the other hand, δ may fall (see Krugman 1990).

Under either an asymmetric or a national productivity shock, $CUFLEX$ and $CUCOOP$ are declining in δ. In both cases, $CULEAD$ first falls then rises as δ increases. $CUFOLL$ displays an opposite pattern under an asymmetric shock but is strictly falling in δ in the latter case, while $CUSYMM$ is rising in δ in the case of a national productivity shock. Again, δ only affects $CUFLEX$ in the case of a common productivity shock and the impact of rising δ is negative in this case. Finally, in the case of an asymmetric demand shock, it is noteworthy that, in addition to $CUSYMM$, $CULEAD$ and $CUFOLL$ are also invariant to changes in δ: the relative comparison between a currency union and an asymmetric fix in responding to asymmetric demand shocks is unaffected by variation in δ. However, both $CUFLEX$ and $CUCOOP$ are rising in δ in this case.

It is noteworthy that a rise in δ or β has opposite effects on $CUFLEX$ and $CUCOOP$, depending on whether asymmetric productivity or demand shocks are being considered. The reason is that, in order to achieve stabilization, both countries wish to expand employment in the former case but adjust employment in opposite directions in the latter case.

The sensitivity of the relative performance of a currency union to variation in σ, the relative weight placed by the monetary authority on price level volatility in its loss function, is examined in Figure 3. This parameter is of central importance in models of inflation determination. For instance, Rogoff (1985b) recommends appointing a central banker with a value of σ higher than the social value of σ in order to achieve a lower average inflation outcome. In our model, in contrast, there is no inflation bias. Since σ both conditions policy responses to shocks and determines the costliness of price level volatility in the monetary authority's loss function, it is unsurprising that σ has a non-monotonic impact on relative welfare in a number of scenarios in Figure 3. These include each comparison under an asymmetric productivity shock and $CULEAD$ and $CUFOLL$ under a national productivity shock as well. In the latter case, $CUFLEX$ and $CULEAD$ are both rising in σ. In the case of a common productivity shock, $CUFLEX$ is rising and $CUSYMM$ is falling in σ. $CUFLEX$, $CUCOOP$ and $CULEAD$ are each declining, but $CUFOLL$ is rising, in σ in the case of an asymmetric demand shock.

In summary, the results in this section indicate that stabilization performance in a currency union, relative to other exchange rate arrangements, can be systemically related to key "integration" parameters. In the core case of asymmetric demand shocks, one dimension of greater economic integration – more similar consumption patterns – tends to reduce the relative unattractiveness of a currency union. If Krugman (1990) is correct in predicting that integration will also lead to greater specialization in production, such that δ falls, the relative performance of a currency union in coping with asymmetric demand shocks is also improved via this channel. However if greater integration rather leads to greater substitutability between home and foreign goods, greater integration will make currency union less attractive, in terms of its stabilization properties in the face of asymmetric demand shocks. Finally, in this context, a larger value for σ makes currency union relatively less unattractive to the leader in an asymmetric fix and relatively more unattractive to the follower. This is consistent with the political economy of the European negotiations, with Germany demanding that price stability be paramount among the ECB's policy objectives. It is important to reiterate that this result is generated only by stabilization considerations, since an inflation bias is not present in the model.

Section VI: Conclusions

In this paper, we have analyzed monetary stabilization policy in a currency union. We have shown that the optimal monetary policy response to asymmetric demand shocks in a currency union is to do nothing. As a consequence, an asymmetric demand shock feeds directly into the real exchange rate and regional price levels and causes a reallocation between domestic and foreign output and employment. However, we also show that it is optimal to respond to positive aggregate productivity shocks by expanding monetary policy.

In addition, we compared outcomes under a currency union to those under alternative exchange rate systems, in order to obtain a sense of the relative performance of a currency union. We showed that the relative stabilization performance under a currency union, versus alternative exchange rate arrangements, is sensitive to the values of some key "integration" parameters but that the impact of variation in these parameters may be quite different effects depending on whether demand or productivity shocks are being considered. In the case of asymmetric demand shocks, greater economic integration in terms of more similar consumption patterns tends to reduce the relative unattractiveness of a currency union in terms of its stabilization properties; a similar story applies if integration leads to greater specialization in production. Finally, another important result in terms of stabilization performance in the face of asymmetric demand shocks is that the relative unattractiveness of a currency union declines, the larger is the relative weight placed on price stability versus employment stability in the monetary authority's objective function.

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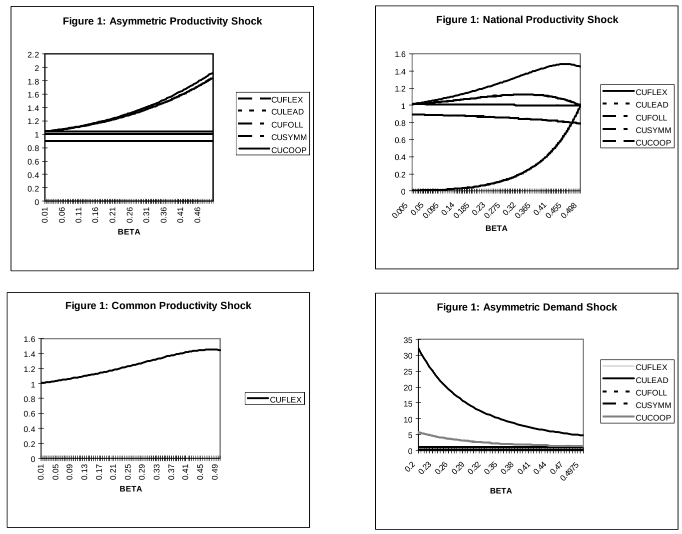

Fig. 1: Sensitivity to β.

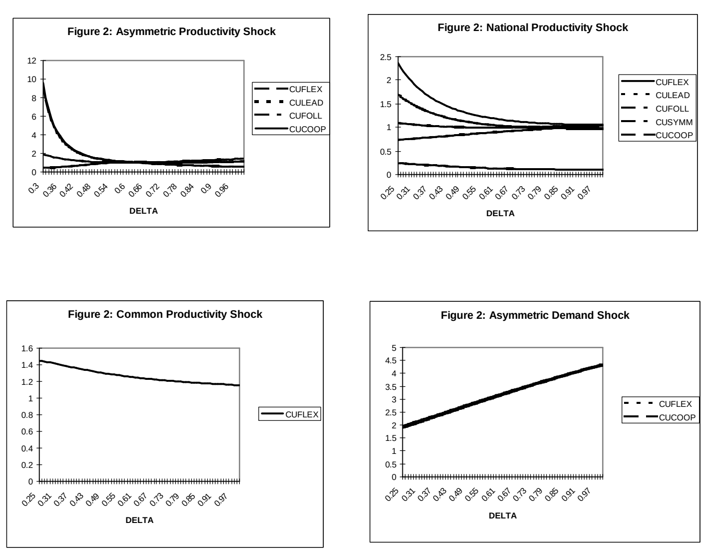

Fig. 2: Sensitivity to δ.

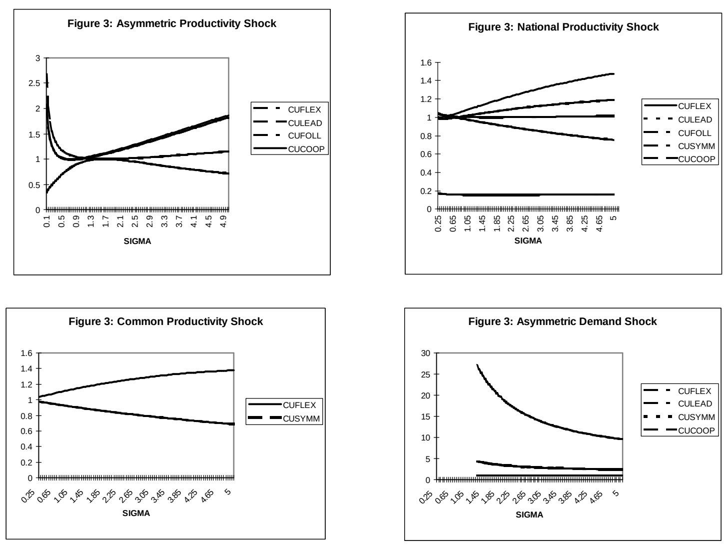

Fig. 3: Sensitivity to σ.