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Is Europe an Optimum Currency Area?
Evidence on the Magnitude and Asymmetry of Common and Country-Specific Shocks in 20 European Countries

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Abstract

This paper asks whether Europe is an optimum currency area. Economic theory suggests that a common currency is more likely to be beneficial if country-specific shocks are mild and symmetric, whereas in the presence of major asymmetric shocks, floating exchange rates are more likely to be stabilizing. Using annual data from the 1950-1990 period, real output fluctuations of 20 European countries (the 15 current members of the European Union, and 5 prospective members) are decomposed into common and country-specific shocks. The decomposition reveals that country-specific shocks in Europe (and the European Union) are both large and asymmetric. These results imply that a common European currency (despite its political attractiveness and potential credibility gains) will have very few stabilization benefits. (JEL Classification: E42, F36, F42)

I. Introduction

This paper asks whether Europe is an optimum currency area. Economic theory suggests that the answer depends on the magnitude and asymmetry

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of the individual economies' shocks. A common currency is more likely to be beneficial if economy-specific shocks are mild and symmetric, whereas in the presence of major asymmetric shocks, floating exchange rates are more likely to be stabilizing.

Annual data from the 1950-1990 period are used to decompose the real output fluctuations of twenty European countries (the fifteen current members of the European Union, and five prospective members) into common and country-specific shocks. The decomposition reveals that while common shocks are of sizable magnitude, they pale in comparison to most of the country-specific disturbances. At the low end, Belgium, France, and Sweden have the smoothest country-specific shocks, whereas Cyprus, Luxembourg, and Turkey are the most volatile.

Next, the paper examines the degree of symmetry across the economies, by investigating the statistically significant correlations between country-specific shocks. Interestingly, no major (and only two minor) blocks of countries become apparent. For example Germany, often mentioned as the likely seat of the European central bank, has country-specific shocks that are positively (and statistically significantly) correlated with no other economy's.

In summary, the paper finds that country-specific shocks in Europe (and the European Union) are both large and asymmetric. These results imply that a common European currency, despite its political attractiveness and potential credibility gains, may have adverse effects on the variability of output.

The remainder of the paper is organized as follows. Section II reviews the optimum currency area literature, and discusses the economics behind the criteria used in this study. Section III describes the econometric methodology and the data, and presents the empirical results. Section IV discusses the implications of these findings and concludes.

II. Background

The *optimum currency area* concept was introduced by Mundell [1961] who used factor (labor and capital) mobility as its most important criterion: if factor mobility between economies in a region is high, the region constitutes an optimum currency area, which means that it should have a common currency. The concept, closely related to the debate between fixed and floating exchange rates, very quickly attracted wide attention. McKinnon [1963] identified openness as a superior criterion: in a very open economy, exchange rate policy will mostly affect prices, so that the cost of giving it up and adopting a common currency is low. Kenen [1969] suggested product diversification as a crucial consideration, and other economists have proposed a number of different criteria.[1]

In a certain sense, these approaches focused mainly on the costs of monetary unification, asking under what conditions these costs would be minimized. More recently, the discussion has evolved to a comparison of costs and benefits. Corden [1973] in an early contribution, Cohen [1989], De Grauwe [1992], and Eichengreen [1992], among others, classify and weigh the pros and cons of monetary integration. The list of benefits includes a reduction in transaction costs, elimination of exchange-rate uncertainty, and enhanced credibility for the monetary authority. Costs (all deriving from the inability to conduct independent monetary policy) include loss of seignorage, inability to select the most desired point on a short-run Phillips curve, and inability to devalue or revalue for stabilization purposes.

When are the benefits more likely to exceed the costs for a given economy? It can be shown that the answer critically depends on the nature of shocks that hit the economy (see the Appendix for a more formal discussion in the context of two simple models). For any set of economies, there are two types of such shocks: *common* shocks that affect all the economies in a similar way (oil shocks, for example), and *economy-specific* shocks that are associated with a single economy (domestic fiscal disturbances, for example). First suppose there is no monetary union, so that each economy can pursue its own independent monetary policy. In principle, this enables each monetary authority to respond both to common and economy-specific shocks and minimize their business-cycle effects. The disadvantage is that this discretionary policy will create credibility problems that will raise the long-run (expected and actual) inflation rate.

Now suppose the economies form a monetary union and surrender mon-

1. See Ishiyama [1975] for a survey of the early literature.

etary authority to a common central bank.[2] Independent monetary policy for each economy is now ruled out. The central bank is still quite able (and, assume, willing) to respond to common shocks, but much less so to economy-specific ones. While in practice, some economy-specific shocks will receive more attention than others depending on the distribution of bargaining power among economies, the average economy in the union will be left with less ability to counteract its domestic disturbances. Therefore, the cost of joining in a monetary union will be small only if most of the shocks that impinge on the economy are common rather than economy-specific. More formally:

Proposition 1*: The milder economy-specific shocks are relative to common shocks, the more likely is a set of economies to be an optimum currency area (see the Appendix for a proof).*

But there is an additional complication. To the extent that some economies in the union will be "more equal" than others, the common central bank will try to smooth some economy-specific shocks more vigorously than others. But because monetary policy is now common, this will spread the consequences of the influential economies' shocks to the rest. For example, a monetary expansion designed to help California get out of a protracted recession will also affect Illinois. Or, a monetary tightening designed to limit the inflationary effects of German reunification will also affect France (demonstrating that this reasoning also applies to "pseudo" unions). Is this propagation of the responses to some economy-specific shocks desirable or detrimental? The answer depends on how economy-specific shocks are correlated. If these shocks are highly synchronized, so that recessions in California and Illinois, or overheating in Germany and France are always simultaneous, then the actions of a common monetary authority are a very good substitute for monetary independence. If, however, economy-specific shocks are asynchronous, monetary union will actually amplify domestic fluctuations. More formally:

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2. "Monetary Union" here is of the "complete" rather than the "pseudo" or "incomplete" version. See Corden [1972] and De Grauwe [1992] for a discussion. The 50 U.S. states are an example of a "complete" monetary union, whereas the EMS is "incomplete".

***Proposition 2**: The more positively correlated economy-specific shocks are, the more likely is a set of economies to be an optimum currency area (see the Appendix for a proof).*

Despite the wide recognition of the importance of these propositions as criteria for an optimum currency area,[3] little empirical research exists on the issue. Bayoumi and Eichengreen [1992] have used the long-run identification restrictions proposed by Blanchard and Quah [1989] to estimate aggregate demand and aggregate supply shocks for 11 EU countries. They find that these shocks are mostly positively related but are significantly more idiosyncratic than shocks from U.S. regions. Karras [1994] used a similar technique to identify employment, technology, and two aggregate demand shocks for France, Germany and the U.K., and also concludes that shocks have been generally synchronous in these countries since 1960.[4]

These studies, however, do not distinguish between common and economy-specific shocks, and as a result, their estimates of overall correlations should considerably overestimate the correlations between economy-specific shocks. Stockman [1988] and Emerson [1992, Annex D], are two studies that separately identify common and nation-specific shocks for several European countries, finding that both types are empirically important. Both studies, however, address only the issue of the relative magnitude of the two types of shocks (Proposition 1), and not their correlations (Proposition 2). The next section describes how Stockman's technique is used in this paper to evaluate both propositions.

III. Methodology and Empirical Results

Let Δy_{it} denote the rate of growth of real *GDP* in economy *i* at time *t*: $\Delta y_{it} \equiv (GDP_{it} - GDP_{it-1})/GDP_{it-1}$. Following Stockman [1988], the following

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3. For similar discussions, see Emerson [1992, Chapter 6], Gros and Thygesen [1992, chapter 7], and Eichengreen [1992, Chapter 3]. It must be pointed out that Porpositions 1 and 2 depend on the presence of nominal rigidities that render monetary policy (potentially) stabilizing. For a proponent of Real Business Cycles, on the other hand, the entire issue would be irrelevant.

4. Karras [1993] also estimates aggregate demand and aggregate supply shocks in Italy, Sweden, and the U.K. for the 1860-1987 period, and finds that aggregate demand shocks have been more synchronous than aggregate supply ones.

Table 1

Three Specifications

		(1)	(2)	(3)
ρ		....	0.11** (0.03)	....
R^2		0.24	0.25	0.26
DW		1.77	1.95	1.95
F-tests:	$w_i = \bar{w}, \forall_i$	2.55**	1.59	1.14
	$v_t = 0, \forall_t$	4.65**	4.51**	4.29**
	$v_t = \bar{v}, \forall_t$	4.69**	4.60**	4.36**
	$\rho_i = 0, \forall_i$	....	....	1.07
	$\rho_i = \bar{\rho}, \forall_i$	....	....	0.61

Notes: (1): $\Delta y_{it} = w_i + v_t + u_{it}$,
(2): $\Delta y_{it} = w_i + \rho \Delta y_{it-1} + v_t + u_{it}$,
(3): $\Delta y_{it} = w_i + \rho_i \Delta y_{it-1} + v_t + u_{it}$.
Standard error in parentheses. ** : significant at 1%.

equation is estimated:

$$\Delta y_{it} = w_i + v_t + u_{it} \tag{1}$$

where w_i is a constant term specific to economy i, v_t is a shock common to all economies at time t, and u_{it} is the i-th economy's specific shock. Econometrically, w_i and v_t are treated as fixed economy- and time-effects, respectively. The *GDP* data are from the Penn World Tables (Mark 5.5), expressed in PPP-adjusted constant prices, as documented in Summers and Heston [1991]. The sample includes twenty European countries: the fifteen EU members, and Cyprus, Iceland, Norway, Switzerland, and Turkey. Data are available from 1950 to 1990.

Column (1) in Table 1 estimates the equation.[5] The time fixed effects are

5. At the suggestion of an anonymous referee, all specifications have been also estimated for the 1950-1988 period, in order to avoid the country-specific shock of German reunification. In addition, a weighted regression was estimated, the weights being based on the relative GDP levels in 1990. Neither the change in sample period nor the weighted approach materially affected the results.

jointly highly significant, and the hypothesis that they do not statistically significantly vary by year can be safely rejected. In addition, the w_is appear to be statistically different from each other which would seem to suggest that the twenty countries are on *diverging* growth paths. Equation (1), however, ignores persistence in output growth, which turns out to be statistically significant. In order to allow for persistence, the equation has been respecified as

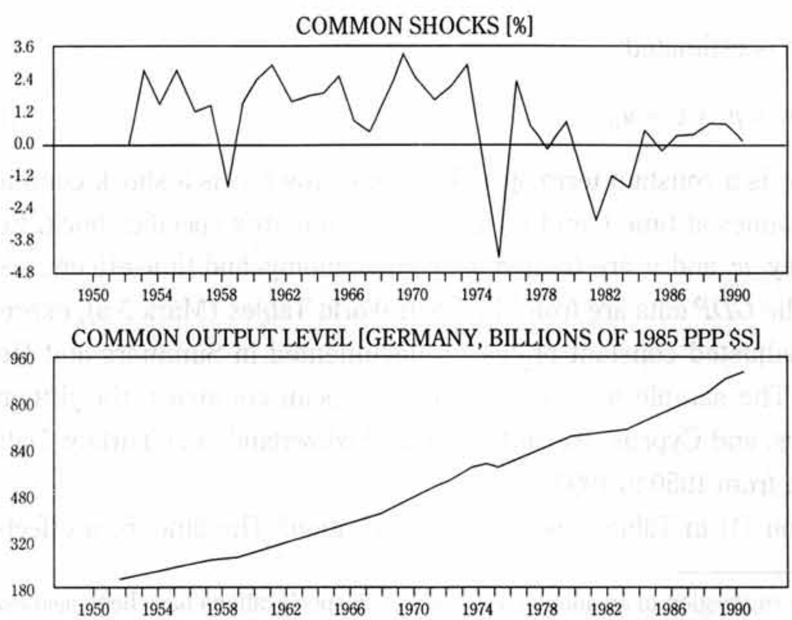
$$\Delta y_{it} = w_i + \rho \Delta y_{it-1} + v_t + u_{it}, \tag{2}$$

and

$$\Delta y_{it} = w_i + \rho_i \Delta y_{it-1} + v_t + u_{it}. \tag{3}$$

The last two columns of Table 1 report the results. Note that the estimated AR(1) coefficient in (2) is highly statistically significant. In addition, allowing for persistence has not affected the v_ts but has reversed the divergence implication: the w_is are not statistically different from each other.[6] As

Figure 1
Common Shocks and (Implied) German Common Trend



6. That the economies of this sample do not diverge is a common finding in the growth and convergence literature. See Evans and Karras (forthcoming) for tests and discussion.

the hypothesis that the $\rho_i s$ in (3) are statistically equal cannot be rejected, everything that follows is based on specification (2) which imposes the same autoregressive parameter on all economies in order to gain efficiency. (The results are virtually identical if specification (3) is used.)

A. Size of Common and Country-Specific Shocks

Let's turn our attention first to Proposition 1. Figure 1 plots the common shocks (the $v_t s$) for the 1951-1990 period. These are sizable and have ranged from 3.31% in 1969 to –4.20% in 1975. These shocks, together with the estimated $w_i s$ can be used to simulate the "common trend" output path of any of the twenty economies over time. The bottom panel of Figure 1 conducts this exercise for Germany.

How does the common shock compare in size with the economy-specific shocks? Despite its significant variability, the common shock is much milder than most economy-specific shocks. These are plotted in Figure 2

Figure 2
Country-Specific Shocks (%), 1950-1990

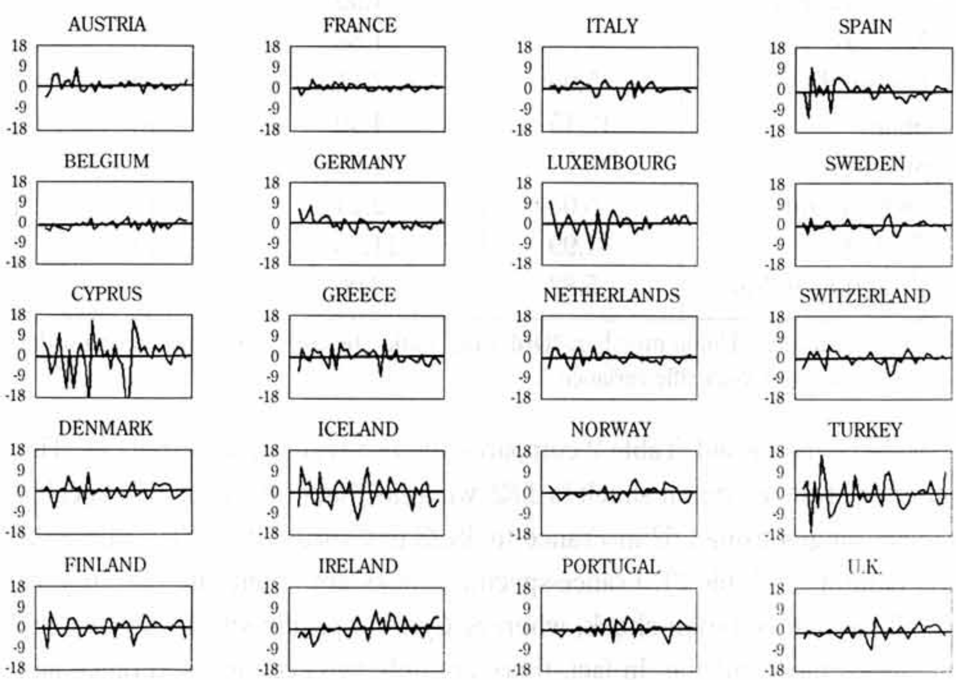


Table 2
Common and Country-Specific Shocks

Common Shock
$var(v_t) = 2.82\%$

Country-Specific Shocks

i	$var(u_{it})$	$var(u_{it})/var(v_t)$	Ordering
*Austria	4.96%	1.76	7
*Belgium	2.16	0.77	2
Cyprus	58.23	20.63	20
*Denmark	6.93	2.46	12
*Finland	10.22	3.62	14
*France	1.62	0.58	1
*Germany	5.31	1.88	8
*Greece	9.88	3.50	13
Iceland	24.55	8.70	18
*Ireland	10.30	3.65	15
*Italy	3.96	1.40	4
*Luxembourg	14.74	5.22	17
*Netherlands	4.48	1.59	6
Norway	4.39	1.56	5
*Portugal	5.96	2.11	10
*Spain	12.15	4.30	16
*Sweden	3.73	1.32	3
Switzerland	6.04	2.14	11
Turkey	31.99	11.33	19
*United Kingdom	5.82	2.06	9

Notes: *: European Union member. "Ordering" ranks the countries in ascending order of country-specific variance.

over the same period. Table 2 compares the two types of disturbances. The variance of the common shock is 2.82, whereas that of the economy-specific shocks ranges from 1.62 in France to 58.23 in Cyprus. Put differently (second column of Table 2), France-specific shocks are about one half time as volatile as the common shock, whereas Cyprus-specific shocks are twenty-one times more volatile. In fact, there are only two economies (France and

Table 3
Correlations Between Country-Specific Shocks

Country	Statistically Significantly Correlated with:	
	Positively	Negatively
Austria	FIN# NET* SPA#	CYP** LUX*
Belgium	FIN# FRA* NET#	GRE#
Cyprus	None	AUS** FIN* NET# SPA# SWE**
Denmark	NOR#	POR*
Finland	AUS# BEL# SPA# SWE** SWI*	CYP* TUR**
France	BEL* SPA**	UK*
Germany	None	POR#
Greece	None	BEL# ITA*
Iceland	None	LUX#
Ireland	None	None
Italy	None	GRE* UK*
Luxembourg	None	AUS* ICE# NET* UK#
Netherlands	AUS* BEL# SWI*	CYP* LUX* TUR*
Norway	DEN# SWE* TUR*	POR* SWI*
Portugal	None	DEN* GER# NOR*
Spain	AUS# FIN# FRA**	CYP#
Sweden	FIN** NOR*	CYP**
Switzerland	FIN* NET*	NOR* TUR**
Turkey	NOR*	FIN** NET# SWE**
U.K.	None	FRA* ITA* LUX#

Notes: **:significant at 1%, *:significant at 5%, #:significant at 10%.

Belgium) that have economy-specific shocks which are milder than the common shock. The remaining eighteen economies are subject to disturbances that are more volatile than the common shock. The last column of Table 2 ranks the twenty economies in ascending order of economy-specific variance. On the basis of Proposition 1, France and Belgium have the least to lose from giving up monetary independence and joining the monetary

Table 4

Correlations Between Country-Specific Shocks

	AUT	BEL	CYP	DEN	FIN	FRA	GER	GRE	ICE	IRE	ITA	LUX	NET	NOR	POR	ESP	SWE	SWI	TUR	UK
Austria	1.0																			
Belgium	.11	1.0																		
Cyprus	-.48**	-.26	1.0																	
Denmark	-.15	-.01	-.02	1.0																
Finland	.29#	.29#	-.34*	-.06	1.0															
France	.08	.32*	-.15	.07	.10	1.0														
Germany	.25	-.14	-.07	.10	.16	.01	1.0													
Greece	-.18	-.30#	.06	.04	-.18	-.03	-.10	1.0												
Iceland	.09	-.16	-.24	-.24	-.20	-.15	-.17	-.02	1.0											
Ireland	-.10	.20	-.14	.12	.10	-.24	-.16	.02	-.09	1.0										
Italy	.11	.21	-.05	-.12	.00	.22	.02	-.32*	-.06	.00	1.0									
Luxembourg	-.35*	-.05	.15	-.02	.09	-.11	.25	-.13	.27#	-.08	-.14	1.0								
Netherlands	.32*	.28#	-.31*	.24	.05	.07	.19	.01	-.01	.05	.00	-.32*	1.0							
Norway	-.20	-.19	-.14	.28#	-.19	-.20	-.23	-.02	.14	-.12	.02	-.16	-.02	1.0						
Portugal	-.08	.21	.08	-.33*	.09	.01	-.30#	-.17	-.07	.20	.24	.01	-.09	-.34*	1.0					
Spain	.31#	.23	-.27#	-.19	.30#	.40**	-.11	-.04	-.19	-.15	-.04	-.10	-.04	-.15	.01	1.0				
Sweden	-.02	.16	-.55**	.20	.53**	.18	.05	.01	-.09	.03	.02	-.17	.09	.34*	-.26	.24	1.0			
Switzerland	.20	.15	-.05	-.02	.40*	.15	.01	-.20	-.07	-.12	.18	-.16	.35*	-.35*	.08	.04	.03	1.0		
Turkey	-.01	-.27	-.16	-.18	-.56**	-.12	-.13	.00	.20	-.10	-.07	.05	-.29#	.32*	-.06	-.19	-.12	-.45**	1.0	
U.K.	.02	-.23	.02	.25	-.15	-.34*	-.17	.10	.04	.05	-.39*	-.28#	-.03	.17	-.05	-.11	-.02	-.16	.04	1.0

Note: Statistically significant at 1% (**), 5% (*), or 10% (#)

union. At the other extreme, the costs for Cyprus, Turkey, Iceland, and Luxembourg are likely to be the greatest.[7]

B. Synchronization and Symmetry of Economy-Specific Shocks

By itself, the fact that most of the economy-specific shocks are more sizable than the common shock is only necessary, but not sufficient to rule out an optimum currency area for these twenty economies. It might still be the case that the economy-specific shocks are mostly positively correlated so that, despite their size, they can be largely smoothed by a common monetary authority. This, however, does not appear to be the case.

Table 3 reports all statistically significant correlations between pairs of the twenty economies (Table 4 reports all the estimated correlations). It is worth emphasizing again that these do not test the overall synchronicity of two economies, but rather the synchronicity between their country-specific shocks only. Thus, it is possible that two countries with completely asynchronous (or even negatively correlated) economy-specific shocks, might appear overall to be in phase, simply because of the effects of the common shock.

Table 3 shows that very few statistically significant positive correlations exist, while the number of negative statistically significant correlations is actually greater. In fact almost half of the economies (nine) have specific shocks that are significantly positively correlated with no other's – and this includes Germany, often mentioned as the seat of the "Eurofed", and certainly its most influential member.

Interestingly, some regional positive-correlation groups do emerge. The two most prominent are (i) Belgium, France, and Spain, and (ii) Finland, Norway, and Sweden (the three Nordic countries). Beyond that, and on the basis of Proposition 2, there is very little evidence that these twenty economies (or any major subset) constitute an optimum currency area.

IV. Conclusions

This paper asked whether twenty European countries (fifteen EU members and five prospective members) comprise an optimum currency area. Economic theory suggests that this will be the case if (i) economy-specific

7. Luxembourg, of course, is already monetarily integrated with Belgium.

shocks are small relative to the common shocks, or (/and) (ii) economy-specific shocks are positively correlated. The empirical results presented here imply that none of these conditions is satisfied for the overwhelming majority of these twenty economies. Simply put, they are not an optimum currency area: monetary integration is unlikely to have any stabilization benefits for most of them, and it may actually have adverse effects on output variability.

In practice of course, this conclusion should be qualified, as the stabilization costs must be balanced against any political or credibility gains (real or perceived) from monetary unification. At the current state of knowledge, benefits like these are hard to quantify. It might be worth noting that, while most economists agree that the costs of monetary unification in Europe can be significant, there seems to be a "continental drift" in the perception of the net effects. Thus, the American school of thought appears to warn of the potential that the costs might dominate,[8] while the Europeans sound more optimistic (although not excessively so).[9] Instead of disagreement about the stabilization costs, this drift more likely reflects the different emphasis placed by the two sides on the economic versus the political effects of monetary integration.

Appendix

This Appendix demonstrates Propositions 1 and 2 using two very simple models. The first considers only the stabilization costs of surrendering monetary independence, while the second adds the credibility gain and illustrates the trade-off. In both cases, the relationship of the costs to the size and symmetry of the economy-specific shocks is illustrated.

A. Stabilization Costs of Monetary Integration

Suppose there are N economies, and the reduced-form for output (or output growth) in each economy i (i=1, 2, ..., N) is given by:

8. Eichengreen [1992], Feldstein [1992], and Krugman [1993]. Also see Miron [1989] and Tootel [1990] for the effects of monetary integration in the United States.
9. Bean [1992], De Grauwe [1994], Emerson [1992], and Schlesinger [1994].

$$y_{it} - \hat{y}_{it} = \lambda_i(y_{it-1} - \hat{y}_{it-1}) + \alpha_i m_{it} + \delta v_t + u_{it}, \tag{A1}$$

where $\hat{y}$ is the "natural" rate of output, m is a monetary policy variable, v is a shock common to all N economies, u is an economy-specific shock, $0 < \lambda_i < 1$, $v_t \sim iid(0, \sigma_v^2)$, and $u_{it} \sim iid(0, \sigma_i^2)$. Each monetary authority's goal is to minimize the variability of output around its natural rate, so that the loss function is simply:

$$L_i = E(y_{it} - \hat{y}_{it})^2, \tag{A2}$$

where E is the mathematical expectation operator.

When there is no monetary integration, each central bank can pursue its own monetary policy. Assume that the monetary policy reaction function takes the form:

$$m_{it} = \beta_i v_t + \gamma_i u_{it}, \tag{A3}$$

where the βs and γs are coefficients. (A3), as well as (A2), can be allowed to have a richer lag structure but this will not alter any of our major conclusions. Using (A3) and (A1) to substitute into (A2), and minimizing the loss function with respect to β and yields the optimal reaction coefficients $\beta_i^* = -\delta/\alpha_i$, and $\gamma_i^* = -1/\alpha_i$. Note that this implies $L_i^* = 0$, so that stabilization policy here is very successful.[10]

Now assume the N economies form a monetary union and complete monetary authority is delegated to country 1, so that

$$m_{it} = m_{1t} = \beta_1 v_t + \gamma_1 u_{1t}, \tag{A4}$$

replaces (A3). This assumes that economy 1 dominates monetary policy.[11]

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10. This is mostly by assumption. As Friedman [1953, pp. 117-132; 1969], Brainard [1967], and others have shown, stabilization policies will be less successful, or even counterproductive, if there are significant errors in the money-supply process, or if there is significant uncertainty about the model's parameters, or long and variable lags in the lag structure. Although problems like these almost certainly reduce the effectiveness of active stabilization policy, it is assumed here that they do not render it destabilizing. Fischer and Cooper [1990] for a discussion.

11. This is a simplifying assumption. (Alternatively, economy 1 can be thought of as the "representative" economy.) More realistically, the money supply process would be $m_{it} = m_t = \beta v_t + \Sigma_i \gamma_i u_{it}$, and the loss function $L = \Sigma_i w_i E(y_{it} - \hat{y}_{it})$, where the weights w

Substituting (A4) and (A1) into the loss function for country 1, we get $\beta_1^* = -\delta/\alpha_1$, and $\gamma_1^* = -1/\alpha_1$, so that $L_1 = 0$, and for $i > 1$:

$$L_i = (1-\lambda_i^2)^{-1}[\delta^2(1-k_i)^2\sigma_v^2 + k_i^2\sigma_1^2 + \sigma_i^2 - 2\rho_{i1}k_i\sigma_1\sigma_i] \quad \text{(A5)}$$

where $k_i = \alpha_i/\alpha_1$, and ρ_{i1} is the correlation coefficient of u_{it} and u_{1t}.

Equation (A5) illustrates the consequences of joining a monetary union when the economy i is not the dominant player. While joining the union reduces the destabilizing effects of the common shock v (in fact it eliminates them completely if $\alpha_i = \alpha_1$), it does not reduce the influence of the own country-specific shock u_{it}, *and* it exposes country i to the dominant country's shock u_1.[12] It follows that the higher σ_v^2 is compared to σ_i^2, the smaller the cost of joining the monetary union (Proposition 1). In addition, note that the closer to unity ρ_{i1} is, the smaller the cost of joining the union (Proposition 2). The reason, of course, is that if $\rho_{i1} \approx 1$ minimization of L_1 is a very close substitute to minimization of L_i.

B. Stabilization Costs with Credibility Gains

Following Kydland and Prescott [1977], and Barro and Gordon [1983], assume that each economy's loss function is

$$L_i = \tfrac{1}{2}E[\alpha_i(y_i - \hat{y}_i)^2 + \pi_i^2] \quad \text{(A6)}$$

where y denotes output, π inflation, $\hat{y}$ a target level of output, E the mathematical expectation, and α_i captures the importance of the output target relative to the inflation target. Aggregate supply is given by an expectations-augmented Phillips curve (with slope normalized to unity and "natural" rate normalized to zero for simplicity):

$$y_i = (\pi_i - \pi_i^e) + v + u_i \quad \text{(A7)}$$

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would depend on each economy's bargaining power in teh new central bank. Our assumption is equivalent to $w_1 = 1$, and $w_i = 0$ for all $i = 2, \ldots, N$. It is made mostly for expositional convenience and does not affect the essential conclusions. Fractianni and von Hagen [1990] have formally tested the German Dominance Hypothesis in the EMS.

12. As a recent example, consider the way the effects of German reunification (a Germany-specific shock) spilled over to other EMS countries through higher interest rates.

where π^e is expected inflation, $v\tilde{}(0, \sigma_v^2)$ is a shock common to all N economies, and $u_i\tilde{}(0, \sigma_i^2)$ are economy-specific shocks. By assumption, the realizations of v and u become known after inflationary expectations are set, but before the central bank determines π.[13]

Without a monetary union, when each economy's central bank can pursue independent monetary policy, minimizing (A6) subject to (A7) leads to the following dynamically consistent (Nash) equilibrium:

$$\pi_i = \alpha_i \hat{y}_i - \alpha_i(1+\alpha_i)^{-1}(v+u_i) \tag{A8}$$

and

$$y_i = (1+\alpha_i)^{-1}(v+u_i). \tag{A9}$$

The variability of output is then given by

$$var(y_i) = (1+\alpha_i)^{-2}(\sigma_v^2 + \sigma_i^2) \tag{A10}$$

Note that there is a trade-off between average inflation ($\bar{\pi}_i = \alpha_i \hat{y}_i$) and output variability: if α_i is very low (so that the central bank is very "conservative"), average inflation will be very low, but output very unstable.[14]

Next assume the N economies form a monetary union and monetary authority is delegated to economy 1. Then, at equilibrium, $\pi_i = \pi_1$ and thus $\pi_i^e = \pi_1^e$ for all i, where π_1 is given as in (A8). So,

$$y_i = (\pi_1 - \pi_1^e) + v + u_i = (1+\alpha_1)^{-1}v + u_i - \alpha_1(1+\alpha_1)^{-1}u_1, \text{ and thus}$$
$$var(y_i) = (1+\alpha_1)^{-2}\sigma_v^2 + \sigma_i^2 + \alpha_1^2(1+\alpha_1)^{-2}\sigma_1^2 - 2\rho_{i1}\alpha_1(1+\alpha_1)^{-1}\sigma_i\sigma_1 \tag{A11}$$

It follows, therefore, that joining a monetary union (provided it is dominated by a more "conservative" monetary authority, so that $\alpha_1 \le \alpha_i$ and $\hat{y}_1 \le \hat{y}_i$) will reduce an economy's average inflation rate: $\bar{\pi}_i^{\text{UNION}} = \alpha_1 \hat{y}_1 < \alpha_i \hat{y}_i = \bar{\pi}_i^{\text{INDEPENDENT}}$. At the same time, however, comparing (A11) to (A10) shows that membership in the union may very well raise output variability. This is the cost of

13. Rogoff [1985], Alesina and Grilli [1992, 1994], and De Grauwe [1994] have examined similar models. The main difference between these models and the present formulation is that here the stochastic part of (A7) has two components: one common and one economy-specific.

14. Rogoff [1985] examines the optimal value for a_i. Fischer and Summers [1989] show that a similar trade-off exists if the source of uncertainty is the central bank's inability to determine the inflation rate without error.

membership. From (A11), this cost will be smaller, the smaller is σ_v^2 compared to σ_i^2 (Proposition 1). At the same time, the cost will also be smaller, the closer to unity ρ_{i1} is (Proposition 2).

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