No. 358

MONETARY INTERDEPENDENCE UNDER ALTERNATIVE EXCHANGE - RATE REGIMES: A EUROPEAN PERSPECTIVE

Frederick van der Ploeg

INTERNATIONAL MACROECONOMICS

Centre for Economic Policy Research

ISSN 0265-8003

MONETARY INTERDEPENDENCE UNDER ALTERNATIVE EXCHANGE-RATE REGIMES: A EUROPEAN PERSPECTIVE

Frederick van der Ploeg

Discussion Paper No.358
November 1989

Centre for Economic Policy Research
6 Duke of York Street
London SW1Y 6LA
Tel: (44 1) 930 2963

CEPR Discussion Paper No.358

November 1989

ABSTRACT

Monetary Interdependence Under Alternative Exchange-Rate Regimes: A European Perspective*

This paper analyses and compares the effects of common demand and supply shocks on the setting of optimal monetary policies under a clean float, a managed exchange rate system (such as the EMS) and a monetary union, when welfare depends on unemployment and the cost of living. The results suggest that monetary union yields the smallest welfare loss and a float the greatest, and that the EMS gives France and Italy the opportunity to appreciate their currencies and reduce their welfare loss at the expense of Germany. The robustness of the results with respect to rational expectations and wage-price dynamics is verified with the aid of differential game theory and numerical simulation.

JEL classification: 430
Keywords: EMS, EMU, macroeconomic interdependence, policy coordination, monetary policy

CentER for Economic Research
Tilburg University
P.O. Box 90153
5000 LE Tilburg
The Netherlands
Tel: +31 13 662770

* An earlier version was presented at the conference on 'European Economic Integration: Towards 1992', organised by the National Bureau of Economic Research and CEPR on 3-4 August 1989, in Cambridge, MA. The author is grateful for the useful comments of the participants at this conference and of Ton Barten. This paper is produced as part of a CEPR research programme on International Macroeconomics, supported by grants from the Ford Foundation (no. 890-0404) and the Alfred P Sloan Foundation (no. 88-4-23), whose help is gratefully acknowledged.

Submitted November 1989

NON-TECHNICAL SUMMARY

The European Monetary System (1979-) can be characterized by German hegemony very much as the Gold Standard (1870-1914) was characterized by UK hegemony and the latter part of the Bretton Woods period (1968-73) by US hegemony. These are three examples of managed exchange rate regimes in the sense that the German (UK or US) central bank sets the monetary policy for the whole region, while the central banks of the other countries effectively peg (pegged) their currencies to the Deutschmark (pound or dollar). The first stage of the proposals of the Delors Committee for economic and monetary union in Europe has, in principle, been accepted by the Council of Ministers on 26-27 June 1989 in Madrid. Spain has now joined the European Monetary System and even the United Kingdom has agreed to join, providing the majority of capital markets in Europe are liberalized by 1 July 1990 and inflation in the United Kingdom is cut to the European average. Although we are still some way from the establishment of a European Central Bank and of full monetary union throughout Europe, it is important to investigate the disadvantages of a European Monetary System compared with European Monetary Union. For completeness, it is sensible also to discuss what happens when the European Monetary System breaks down and thus to include a comparison with a regime of floating exchange rates, such as the periods when national money supply targets prevailed for most of the OECD countries (1973-85).

In the light of the above, this paper examines the effectiveness and need for the international coordination of monetary policy, in the face of unemployment and inflation caused by adverse shifts of demand or supply, under three alternative exchange rate regimes: (i) floating exchange rates; (ii) managed exchange rates and hegemony (the European Monetary System); (iii) irrevocably fixed exchange rates and a centralized monetary policy (European Monetary Union). Since the European Community has decided that eight member countries will have fully liberalized capital movements by 1 July 1990, with other countries following suit, it seems reasonable to assume perfect capital mobility (and uncovered interest parity) in each of these three regimes. It is assumed that goods produced in the various European countries are imperfect substitutes and that there is no labour mobility between the various European countries. The theoretical analysis is conducted within the framework of a standard two-country Mundell-Fleming model and compares cooperative outcomes with non-cooperative (Nash-Cournot) outcomes under the three alternative exchange rate regimes. Subsequently, the two-country model is extended to allow for rational expectations and wage-price dynamics and uses differential game theory and numerical simulation to assess the robustness of the analytical results. Policy responses to both common and idiosyncratic shocks are considered.

Consider first the effects of adverse demand shocks under the three exchange rate regimes. In the face of an adverse demand shock common to both countries, monetary policy expands to ensure full employment. There is no conflict over the cost of living, so there is no need for international policy coordination under any of the three regimes. In the face of a change in preferences away from the goods of country 1 towards the goods of country 2, monetary union performs very badly compared with the other two exchange rate regimes, because the exchange rate is not able to depreciate. This is the main reason why, when there are rigidities in labour markets, one might advocate the establishment of a Federal Fiscal Authority in conjunction with the establishment of a Federal Monetary Authority. Its task in the presence of such a shock should be to transfer income from country 2 to country 1. It is a pity that the Delors Report did not advocate the establishment of such a Federal Fiscal Authority for Europe.

In the face of a common adverse supply shock, however, a monetary union performs much better than a regime of floating exchange rates. The reason is that competitive, futile attempts to appreciate the currency and export inflation are avoided. A non-cooperative float then leads to monetary stances that are too tight, interest rates that are too high and excessive unemployment. Under the European Monetary System, the central banks of Europe other than the Bundesbank do manage to appreciate their currencies vis-à-vis the Deutschmark and thus to disinflate away some of the adverse consequences of a common supply shock. Because Germany suffers a large loss in real income, it experiences a greater welfare loss than the rest of Europe. In addition, Germany is worse off under managed exchange rates than under monetary union while the rest of Europe is better off. This may be one of the few reasons why Germany may be keen to join a more symmetric European System of Central Banks. The rest of Europe is better off than with a non-cooperative float, but Germany is only better off when countries care relatively more about inflation and the cost of living than unemployment. In the face of an idiosyncratic, adverse supply shock, a monetary union performs much worse, in terms of the average European welfare loss, than either a cooperative or a non-cooperative regime of floating or managed exchange rates. The reason is, of course, that the currency of the affected country cannot appreciate in response to excess demand for goods.

The move towards monetary union in Europe is thus much more justified in the presence of common shocks than in the presence of idiosyncratic shocks. This means that the establishment of a Federal Fiscal Authority may be essential in order to offset idiosyncratic shocks. A first-best solution, however, is to ensure either that labour markets clear immediately or that factor (in particular labour) mobility is very high throughout Europe. It also contributes to the success of the move towards monetary union that countries should have a high proportion of traded goods in domestic output and a high degree of product diversification, financial integration and policy and political integration.

Unfortunately, labour markets do not function properly and cultural and language barriers prevent a high degree of labour mobility. The move towards monetary union must therefore be accompanied by the appropriate design of a fiscal institution at a European level, in order to compensate for giving up monetary and exchange rate policy as an independent instrument of economic policy. The other advantages of moving towards full monetary union in Europe can then be achieved as well: reduction in exchange rate risk; fewer speculative capital flows and no more speculative attacks, thus facilitating the liberalization of capital markets throughout Europe; saving on foreign exchange reserves; a greater weight in negotiations regarding the global management of exchange rates with Japan and the United States; the efficiency of a single currency as a unit of account and store of value; weakening of German hegemony in monetary policy, which may mean that Germany is more likely to have a looser fiscal stance, carry its full burden of fighting unemployment in Europe and be 'a locomotive engine of growth'; fewer transaction and information costs; better monetary discipline and lower inflation rates.

Two problems then remain. The first is that the presence of a large black economy in Southern Europe justifies a higher optimal inflation tax for Southern than for Northern Europe and thus justifies a crawling peg between Southern and Northern Europe. It can be argued, however, that countries with a large public nominal debt, such as Italy, have a big temptation to use surprise inflation to erode the real value of debt. But since the private sector anticipates this, there will be higher inflation rates in equilibrium. A clear commitment to peg the exchange rate to a low-inflation, common currency area eliminates this inefficiency and may therefore be optimal, despite a reduction in seigniorage revenues. The second problem is that, even when the countries of a monetary union are hit by a common adverse supply shock, there may be potential advantages associated with international coordination of fiscal policies, so appropriate supra-national institutions must be created in order to ensure that this happens. This need arises either when a European System of Central Banks is independent and is not willing to use the European money supply for stabilization purposes so that fiscal policy must be called upon, or when the countries forming a European Monetary Union strategically interact with the United States. The latter situation arises because Europe's trade balance determines its real exchange rate vis-à-vis the United States and thus effectively is a public good; its provision may, in the absence of international coordination of fiscal policies, be inefficient.

1. Introduction

The European Monetary System is characterised by Germany hegemony in very much the same way that the Gold Standard was characterised by UK hegemony and Bretton Woods by US hegemony (e.g. Giavazzi and Giovannini, 1989). These are examples of managed exchange-rate regimes in the sense that Germany (UK or US) sets monetary policy for the region whilst the other countries effectively peg (pegged) their currencies to the Deutschemark (the pound or the dollar). In view of the arguments put forward by the Delors Committee in favour of economic and monetary union in Europe and the establishment of a European Central Bank, it is of importance to investigate the disadvantages of the European Monetary System compared with a European Monetary Union. This paper looks at the effectiveness and need for coordination of monetary policies, in the face of unemployment and inflation caused by adverse demand and supply shocks, under three regimes: (i) floating exchange rates; (ii) managed exchange rates and hegemony (the European Monetary System); and (iii) irrevocably fixed exchange rates and a centralised monetary policy (European Monetary Union). Since the European Community has already decided that eight member countries will have fully liberalised capital movements by 1st July 1990 and that the other countries will follow suit, it seems reasonable to assume perfect capital mobility in each of these three regimes.

Section 2 uses a standard two-country Mundell-Fleming model to assess the international coordination of monetary policies under a regime of floating exchange rates. Section 3 does the same for an asymmetric regime of managed exchange rates, such as the European Monetary System, and Section 4 interprets the results and compares them with the outcome under monetary union. The results are related to the findings of Giavazzi and Giovannini (1989b). Section 5 extends the model to allow for rational expectations and wage-price dynamics and uses differential game theory and numerical simulation to assess the robustness of the previous results. Section 6 examines to what extent idiosyncratic supply shocks harm the case for a European Monetary Union. Section 7 concludes the paper and offers an assessment of the case for monetary union.

2. Monetary policies under floating exchange-rates

A short-run Keynesian two-country model with nominal wage rigidity, immobility of labour, imperfect substitution between home and foreign goods, perfect capital mobility and, for the time being, static expectations can be written as:

$$y = -\bar{\sigma}\, r + \bar{\delta}\,(p^*+e-p) + \bar{f} + \gamma y^*,\ 0 \leq \gamma < 1 \tag{1}$$

$$y^* = -\bar{\sigma}\, r - \bar{\delta}\,(p^*+e-p) + \bar{f}^* + \gamma y,\ \bar{\sigma},\ \bar{\delta} > 0 \tag{2}$$

$$m - p = y - \lambda r,\ \lambda > 0 \tag{3}$$

$$m^* - p^* = y^* - \lambda r \tag{4}$$

where y, $\bar{f}$, r, p, e and m denote real output, a demand shock, the (world) interest rate, the price level (an adverse supply shock), the nominal exchange-rate (price of foreign exchange in terms of domestic currency) and the money supply, respectively. Variables are expressed as percentage deviations from their steady-state values, except for r which is expressed as an arithmetic deviation from its equilibrium value. Foreign variables are denoted with an asterisk. Under floating exchange-rates both money supplies are exogenous policy instruments, since the exchange rate adjusts to keep the balance of payments in equilibrium. It follows that:

$$r = \tfrac{1}{2}[(1+\gamma)\,(f+f^*) - (m-p) - (m^*-p^*)]/(\sigma+\lambda) \tag{5}$$

$$c \equiv p^*+e-p = \tfrac{1}{2}[(m-p) - (m^*-p^*) + (1-\gamma)\,(f^*-f)]/\delta \tag{6}$$

$$y \equiv \tfrac{1}{2}[(2\sigma+\lambda)\,(m-p) - \lambda(m^*-p^*) + (1+\gamma)\lambda\,(f+f^*)]/(\sigma+\lambda) \tag{7}$$

where $\sigma \equiv \bar{\sigma}/(1-\gamma)$, $\delta \equiv \bar{\delta}/(1+\gamma)$ and $f \equiv \bar{f}/(1-\gamma^2)$. Hence, a monetary expansion reduces world interest rates, leads to a depreciation of the real exchange rate and is a beggar-thy-neighbour policy. A (bond-financed) fiscal expansion increases world interest rates, leads to an appreciation of the

real-exchange rate and is a locomotive policy. These results confirm the well-known analysis of Mundell (1968).

We will assume that each central bank is concerned about achieving on the one hand full employment and on the other hand ensuring a low cost-of-living index,

$$p_c = (1-\alpha)p + \alpha(p^*+e) = p + \alpha c, \quad 0 < \alpha < 1 \tag{8}$$

where α denotes the share of imports in final expenditures. Hence, the problem for the home central bank is

$$\min_{m} W \equiv (y-y^d)^2 + \bar{\vartheta}\,(p_c+\bar{\omega})^2, \quad y^d, \bar{\omega}, \bar{\vartheta} \geq 0 \tag{9}$$

and similarly for the foreign central bank. For example, a common adverse demand shock ($f=f^*=-d < 0$) causes unemployment and leaves the cost-of-living index unaffected, so the targets $y^d=(1+\gamma)\lambda d/(\sigma+\lambda) > 0$ and $\bar{\omega}=0$ are warranted. Alternatively, a common adverse supply shock (e.g., an increase in the wedge between producers' and consumers' wage, a detoriation in productivity or an increase in oil prices, $p=p^*=s > 0$) causes unemployment and an increase in the cost-of-living index, so $0 < y^d = \sigma s/(\sigma+\lambda) < s$ and $\bar{\omega}=s$ are warranted.

The non-cooperative outcome is where m minimises W given m^* and when m^* minimises W^* given m and is denoted by the subscript F. The cooperative outcome is where m and m^* jointly minimise the global welfare loss, $W + W^*$, and is denoted by the subscript U (as it will correspond to the outcome under monetary union). It is straightforward to establish that

$$m_F \equiv \left[\frac{\sigma+\lambda}{\sigma}\right][y^d - (\vartheta/\hat{\sigma})\omega] < m_U \equiv \left[\frac{\sigma+\lambda}{\sigma}\right]y^d \tag{10}$$

where $\frac{1}{2} < \hat{\sigma} \equiv (\sigma+\frac{1}{2}\lambda)/(\sigma+\lambda) < 1$, $\vartheta \equiv \frac{1}{4}\bar{\vartheta}\alpha^2/\delta^2$ and $\omega \equiv 2\delta\bar{\omega}/\alpha$. Note that a common demand shock creates no need for the international coordination of monetary policies, because non-cooperative decision-making already achieves full employment ($m_F = m_U = (1+\gamma)\lambda d/\sigma$, $y_F = y_U = y^d$). World interest rates fall ($r_F = r_U = -(1+\gamma)d/\sigma$), both because of the fall in the demand for goods caused by the shock and by the induced monetary expansions. A common adverse supply shock does create a need for international policy coordination, because

otherwise monetary policies would be too tight and consequently there would be unemployment ($y_F = y^d - (\vartheta/\hat{\sigma})\omega < y_U = y^d$). The reason is that, in the absence of coordination, each central bank attempts to export inflation by appreciating its exchange rate. Policy coordination realises that such competitive appreciations are futile. Similar results are obtained by Oudiz and Sachs (1984), by Canzoneri and Henderson (1987), and by Oudiz and Sachs and others in Buiter and Marston (1985).

3. Managed exchange rates

The previous section considered the coordination of monetary policies under a clean float. Here an asymmetric regime of managed exchange rates is considered. In particular, the foreign central bank is assumed to be in full control of its money supply whilst the home central bank manages its exchange rate and thereby gives up an independent monetary policy. This is in accordance with the view that the European Monetary System operates as a greater Deutschemark zone (Giavazzi and Giovannini, 1989a); the Bundesbank determines the monetary policy for the whole of Europe whilst the other central banks of Europe peg and periodically realign their currencies vis-à-vis the Deutschemark. Similarly, it can be argued that the Gold Standard was characterised by UK hegemony and Bretton Woods by US hegemony. If there is pressure on the home currency to devalue ($e\uparrow$), the home central bank sells foreign currency in exchange for home currency in order to meet the deficit on the balance of payments and thereby defends its exchange rate. There is a corresponding fall in the home money supply, so that the home central bank cannot have an independent monetary policy. When e and m^*, rather than m and m^*, are exogenous, equations (5)-(7) can be rewritten as:

$$r = [-\delta e - m^* + \gamma f + f^* + \delta p + (1-\delta)p^*]/(\sigma+\lambda) \tag{11}$$

$$m = 2\delta e + m^* + (1-\gamma)(f-f^*) + (1-2\delta)(p-p^*) \tag{12}$$

$$y = [\sigma m^* + ((1-\gamma)\sigma+\lambda) f - ((1-\gamma)\sigma-\gamma\lambda)f^* + (2\sigma+\lambda)\delta(e-p) - ((1-2\delta)\sigma - \delta\lambda)p^*]/(\sigma+\lambda). \tag{13}$$

$$y^* = [\sigma m^* + \lambda (\gamma f + f^*) - \lambda\delta(e-p) - (\sigma+\lambda\delta)p^*]/(\sigma+\lambda). \qquad (14)$$

A contraction in the German money supply ($m^*\downarrow$) leads to an equal fall in, say, the French money supply, because the French are defending themselves against a depreciating currency by buying up francs. Hence, the increase in European interest rates and the associated crowding out of private consumption and investment throughout Europe is twice as large as under a clean float. With a fixed exchange rate, there is no adverse effect on German net exports and employment arising from an appreciation of the Deutschemark and therefore monetary contraction in Germany increases unemployment throughout Europe by the same amount. Conversely, a German monetary expansion is now a locomotive (rather than) a beggar-thy-neighbour policy.

A devaluation of the currencies of the rest of Europe vis-à-vis the Deutschemark ($e\uparrow$) improves net exports to Germany and thus boosts non-German employment and output and increases unemployment in Germany. To choke off the resulting excess supply of German money, European interest rates fall and as a result non-German money demand increases in line with non-German money supply. Since the European money supply increases and European interest rates fall, the increase in non-German output exceeds the fall in German output. Clearly, such a devaluation is a beggar-thy-neighbour policy. However, it increases the cost of living at home and decreases it in Germany.

We will now look at the situation where the central banks of the rest of Europe periodically realign and control their exchange-rate (e) to minimise W (given by (9)) and the Bundesbank chooses its money supply (m^*) to minimise W^*. Any complications arising from speculative attacks, e.g., agents selling liras for Deutschemarks, when a devaluation of the lira is anticipated, and credibility are ignored, even though all capital controls are assumed to be abolished. The reaction function of the Bundesbank is upward-sloping, because a devaluation of the other currencies causes German unemployment and a fall in the German cost of living so that the Bundesbank reacts with a monetary expansion. The reaction functions of the other central banks are downward-sloping, because a German monetary expansion boosts employment elsewhere in Europe and therefore the other central banks can afford to pay more attention to their cost-of-living targets and

appreciate their currencies. Intersection of the reaction functions yields the outcome for a non-cooperative managed exchange-rate regime, which is denoted by the subscript M:

$$e_M = -[\vartheta/2\delta\ (\vartheta+\hat{\sigma})]\omega \leq e_F = e_U = 0 \tag{15}$$

$$m^*_M = \left[\frac{\sigma+\lambda}{\sigma}\right]y^d - \left[\frac{\lambda\vartheta}{2\sigma(\vartheta+\hat{\sigma})}\right]\omega \leq m^*_U \tag{16}$$

$$m_F = m^*_F \leq m_M = \left[\frac{\sigma+\lambda}{\sigma}\right]y^d - \left[\frac{(2\sigma+\lambda)\vartheta}{2\sigma(\vartheta+\hat{\sigma})}\right]\omega \leq m^*_M \leq m_U = m^*_U \tag{17}$$

$$r_U \leq r_M = -[y^d - \tfrac{1}{2}\vartheta(\vartheta+\hat{\sigma})^{-1}\omega]/\sigma \leq r_F \tag{18}$$

$$y_M = y^d - \vartheta(\vartheta+\hat{\sigma})^{-1}\omega \leq y_U = y^d \tag{19}$$

$$y^*_M = y^*_U = y^d \geq y_M \geq y_F = y^*_F. \tag{20}$$

The cooperative outcome chooses e and m^* to minimise the European welfare loss ($W+W^*$) and yields the same full-employment outcomes as a cooperative clean float: $e_U = 0$, $y_U = y^*_U = y^d$, $m_U = m^*_U = (\sigma+\lambda)y^d/\sigma$ and $r_U = r^*_U = -y^d/\sigma$. In fact, it can be shown that international policy coordination under a managed exchange-rate system or under a clean float yields the same outcome as a European Monetary Union and are therefore all denoted by the subscript U. The associated welfare losses are:

$$0 \leq W_M = \vartheta\omega^2\ [(\vartheta+\hat{\sigma}^2)/(\vartheta+\hat{\sigma})^2] \leq W_U = W^*_U = \vartheta\omega^2 \leq \tfrac{1}{2}(W_M + W^*_M) \leq$$

$$W^*_M = \vartheta\omega^2\ [(2\vartheta+\hat{\sigma})/(\vartheta+\hat{\sigma})]^2. \tag{21}$$

In addition, it can be shown that [1]

---

[1] The proof is that this inequality requires for $\omega>0$ that $g(\vartheta) \equiv \vartheta^2 + \hat{\sigma}(2-\hat{\sigma})\ \vartheta + \tfrac{1}{2}\hat{\sigma}^2 > 0$, which is the case as $g(0) = \tfrac{1}{2}\hat{\sigma}^2 > 0$ and $g'(0) = 2\vartheta + \hat{\sigma}(2-\hat{\sigma}) > 0$.

$$\tfrac{1}{2}(W_M + W_M^*) \leq W_F = W_F^*. \qquad (22)$$

One cannot say whether $W_F = W_F^*$ is less or greater than W_M^*. However, one can show that $W_F = W_F^*$ is less (greater) than or equal to W_M^*, whenever ϑ is small (large)[2].

4. Interpretation of the results and comparison with monetary union

The interpretation of the above results is as follows:

(i) Coordination of monetary policies in the face of a common adverse demand or supply shock leads to full employment throughout Europe, irrespective of whether intra-European exchange rates float, are managed or are irrevocably fixed. This is achieved with an equal increase in all European money supplies and a fall in European interest rates, whilst intra-European exchange rates are unaffected. Hence, international coordination of monetary policies within Europe may facilitate the move towards a European Monetary Union.

(ii) In the face of a common adverse demand shock ($y^d > 0$, $\omega=0$), there is no need for international policy coordination as it does not create international conflict over the cost of living. This result holds for a clean float, the European Monetary System and a European Monetary Union.

(iii) A common adverse supply shock leads under a non-cooperative European managed exchange-rate system to an appreciation of the lira, franc and guilder vis-à-vis the Deutschemark even though the European economies are assumed to have symmetric structures and are hit by identical shocks. Hence, the non-German economies use an appreciation of the real exchange rate to disinflate away the consequences of an adverse supply shock. This occurs because the Bundesbank expands its money supply by more than the other European central banks. Germany achieves full employment but does not score

---

[2] $W_F = W_F^* < W_M^*$ requires that $f(\vartheta) \equiv \vartheta^2 + (2\hat{\sigma}-3\hat{\sigma}^2)\,\vartheta + \hat{\sigma}^2 - 2\hat{\sigma}^3 < 0$, so that $f(0) = \hat{\sigma}^2(1-2\hat{\sigma}) < 0$ and $f''(0) = 2$. Hence, this inequality holds for small ϑ and is violated for large ϑ.

on its cost-of-living target, whilst the rest of Europe scores less well on the unemployment target, but scores somewhat on its cost-of-living target. The rest of Europe achieves a smaller welfare loss than Germany, so that the exchange-rate realignment allows the rest of Europe to reduce the damage to its welfare at the expense of Germany.

(iv) Comparison of a non-cooperative managed exchange-rate system or a European Monetary Union with a non-cooperative float shows that the latter leads to lower money stocks, higher interest rates and more unemployment because the latter leads to futile attempts to engage in competitive appreciations of the exchange rate and export inflation abroad.

(v) Comparison of a non-cooperative managed exchange-rate system with a European Monetary Union shows that the latter leads to higher money supplies and lower interest rates and thus to full employment in both Germany and the rest of Europe. A managed exchange-rate system is worse for Germany (despite the fact that there is full employment in Germany) and better for the rest of Europe than a monetary union and for Europe as a whole it is worse than a monetary union. This is a reason why Germany may be keen on the recommendations for a more symmetric European System of Central Banks, recently proposed by the Delors Committee, and why the rest of Europe may be less keen.

(vi) A European Monetary Union yields exactly the same outcome as a cooperative float or a cooperative European Monetary System and yields the smallest welfare loss. A non-cooperative float yields the highest welfare loss, which is due to each central bank engaging in competitive, futile attempts to appreciate the currency and export inflation. Under the European Monetary System France and Italy are better off than under monetary union whilst Germany is worse off, but on average Europe is better off with the European Monetary System than with a non-cooperative float and worse off with the European Monetary System than with a monetary union.

(vii) When countries are very conservative, i.e., care relatively much more about the cost of living than unemployment, then Germany prefers the European Monetary System to a non-cooperative float, else Germany prefers a floating exchange-rate regime. The reason is, of course, that the European Monetary System avoids to a certain extent competitive, **futile** attempts to appreciate the currency and thus leads to looser monetary policies and less unemployment.

Giavazzi and Giovannini (1989b) also show that the non-German economies in a European managed exchange-rate system use an appreciation of the real exchange rate to disinflate a common adverse supply shock. However, their model does not have the real exchange rate affecting the cost of living but affecting aggregate supply through the usage of imported raw materials and their analysis does not fully compare welfare of the countries concerned for the alternative exchange-rate regimes. They also argue that with a country-specific demand shock, Germany can be better rather than worse off than the rest of Europe under a managed exchange-rate system. This result arises from the negative spill-over effects which in part relieve Germany from the bias in non-cooperative decision making. Basevi and Giavazzi (1987) perform a number of numerical exercises when the European economies do not have identical structures and then, even under a monetary union, intra-European exchange rates need not remain fixed. This suggests that the completion of a common European market is a prerequisite for full monetary union within Europe. Kenen (1987) uses a two-country portfolio-balance model to analyse the question which exchange-rate regime allows individual governments to achieve their national objectives without international policy coordination and finds that the answer depends on both the nature and origin of the shock (cf., Section 6).

5. Rational expectations and wage-price dynamics

The analysis conducted in this paper is, of course, relevant for the understanding of non-cooperative stabilisation policies under alternative exchange-rate regimes and finds that a European Monetary Union is the most desirable regime, but is of limited interest as the analysis did not consider wage-price and/or exchange-rate dynamics. The studies in Buiter and Marston (1987) report numerical policy coordination exercises that allow for rational expectations and wage-price dynamics, but are unfortunately restricted to regimes of floating exchange rates. This section therefore uses numerical methods to examine the robustness of our analytical results with respect to rational expectations and wage-price dynamics. The extended model is given by: (1), (8),

$$m-p = y - \lambda i, \quad \lambda>0 \tag{23}$$

$$i \equiv r + E\dot{p}_c = i^* + E\dot{e} \tag{24}$$

$$\dot{w} = \varphi(y-\bar{y}),\ \bar{y} \equiv \bar{n}-s,\quad \varphi>0 \tag{25}$$

$$p = w+s \tag{26}$$

and the foreign equivalents of equations (1),(8),(23),(24) and (25), where $r,i,w,s,\bar{y}$ and $\bar{n}$ denote the real interest rate, the nominal interest rate, the nominal wage, a deterioration in labour productivity (an adverse supply shock), full-employment output and the labour force, respectively. Equation (24) captures uncovered interest parity ensured by risk-neutral arbitrageurs in foreign-exchange markets, whilst equation (25) captures sluggish wage-price dynamics. Wages and prices in each country are predetermined and historically given. Under a clean float each central bank can control its money supply and the exchange rate is non-predetermined and jumps in response to "news" about future events. Under a managed float Germany has full control of its money supply, m^*, and the rest of Europe pegs their currencies to the Deutschemark. Under monetary union the European System of Central Banks (ESCB) sets the European money supply, $m_E \equiv \frac{1}{2}(m+m^*)$, and sets the intra-European exchange rate once and for all. Under the latter two regimes the private sector does not expect adjustments in the exchange rate.

The short-run effects of supply shocks and monetary policy under the three regimes are, apart from initial jumps in the exchange rate and inflation, as before. In the long run output is at its full-employment level, $y(\infty)=\bar{n}+s$, inflation is zero, interest rates are given by

$$i(\infty) = i^*(\infty) = \frac{1}{2\sigma}\,[\bar{f}+\bar{f}^*+(1-\gamma)(s+s^*)], \tag{27}$$

the real exchange rate is given by

$$c(\infty) = \frac{1}{2\delta}\,[(1+\gamma)(s^*-s)-\bar{f}+\bar{f}^*], \tag{28}$$

and real income, $\omega \equiv w-p_c$, is given by

$$\omega(\infty) = -s + \left[\frac{\alpha}{2\delta}\right][(1+\gamma)(s-s^*)+\bar{f}-\bar{f}^*]. \tag{29}$$

Table 1 illustrates the effects of a common adverse supply shock ($s=s^*>0$). Initially output falls, but by less than the fall in full-employment output. Hence, subsequently wages and real interest rates rise so that output falls until the lower equilibrium value has been reached. Real income falls immediately by the full extent of the adverse supply shock. Policy follows from the intertemporal welfare loss function:

$$W = {}_0\int^{\infty}\exp(-\rho t)[y^2+\vartheta_1\omega^2+\vartheta_2 m^2]dt, \tag{30}$$

where ρ denotes the rate of discount. The outcomes are calculated as the outcome of a differential game (van der Ploeg and Markink, 1989) and are also reported in Table 1.

Most of the earlier literature on international coordination of macroeconomic policies has focussed on the coordination of monetary policies in a regime of floating exchange rates and has used two-country real-exchange-rate overshooting models as a framework of analysis (e.g., Miller and Salmon, 1985; Oudiz and Sachs, 1985). One of the lessons is that international coordination of monetary policies can be counterproductive, because it worsens the credibility and destroys the discipline of central banks (Rogoff, 1985; Van der Ploeg, 1988). The reason is that, when a central bank reneges and implements a surprise increase monetary expansion, this leads to a depreciation of the currency and inflation. This disincentive to renege does not exist when there is international policy coordination as then the exchange rate is unaffected , so that this results in looser monetary policies and higher prices in equilibrium. The results presented in Table 1 for a regime of floating exchange rates show, however, that coordination in the absence of credibility need not always be counterproductive. One does have, in the absence of pre-commitment, higher money supplies and thus higher prices and lower real income, but this also leads to less output losses and thus to smaller welfare losses than when central banks can pre-commit themselves to their announced monetary policies.

The main result of Section 4 that a non-cooperative float yields the highest welfare loss and that European Monetary Union corresponds to a cooperative float or a cooperative European Monetary System and yields the

lowest welfare loss is robust to extending the model by allowing for wage-price and exchange-rate dynamics. The reason is again that under a regime of floating exchange rates each central bank tries to export inflation by engaging in competitive, futile attempts to appreciate the currency, whilst a regime of irrevocably fixed exchange rates avoids such beggar-thy-neighbour inefficiencies. Table 1 confirms the result that on average Europe is better off with monetary union and worse off with a regime of floating exchange rates than with a regime of managed exchange rates. Furthermore, under the European Monetary System central banks other than the Bundesbank implement a tighter monetary stance and cause higher interest rates than in Germany and thus manage to appreciate their currencies vis-à-vis the Deutschemark and export inflation. In fact, Table 1 also confirms the result that Germany is worse off than under monetary union and the rest of Europe is better off. Table 1 shows that Germany obtains the same amount of unemployment under managed exchange rates as under monetary union, i.e., less than the rest of Europe, but nevertheless the detoriation of real income (more than the initial impact of the shock) ensures that Germany suffers a greater welfare loss than the rest of Europe.

6. Idiosyncratic supply shocks and the case for monetary union

So far, the non-cooperative responses of monetary policies to a common adverse supply shock under three alternative exchange-rate regimes for Europe have been considered. The main finding has been that for such a shock a monetary union is the preferred arrangement for exchange rates. A second-best exchange-rate regime may be the European Monetary System, because then the futile, non-cooperative attempts to appreciate the currency and expert inflation by tightening monetary policy that occur under a regime of floating exchange rates are also avoided. However, when there is an asymmetric shock, say a shift in preferences away from the goods of country 1 towards the goods of country 2, matters are not so simple. The initial effects of this shock are unemployment and a trade deficit for country 1 and over-employment and a trade surplus for country 2. If labour markets function properly, then wages in country 1 fall immediately and wages in country 2 increase to ensure full employment. In that case, one should

proceed to monetary union and reap all the benefits of a greater common currency area (lower transaction costs, lower information costs, no exchange-rate risk, saving on exchange reserves, etc.). Alternatively, if nominal wage rigidities prevent labour markets from adjusting immediately to full employment, then workers may migrate from country 1 to country 2 and restore balance in this way. Unfortunately, Europe is neither characterised by a smooth functioning of its labour markets nor by high degrees of labour mobility (due to differences in language and culture) and therefore some form of policy adjustment is required. The most obvious policy adjustment, in the absence of wage flexibility and labour mobility, is then a loosening of monetary policy in country 1, tightening of monetary policy in country 2 and a depreciation of the exchange rate of country 1 for this boosts net exports of country 1 and restores equilibrium. Of course, this is not possible under a monetary union with irrevocably fixed exchange rates and is only possible to a limited extent under the European Monetary System. This is the main reason why in the presence of asymmetric real shocks a regime of floating exchange rate is to be preferred to a monetary union or, to a lesser extent, to a regime of managed exchange rates. The case for floating exchange rates is convincing when the shock consists of a shift in preferences away from goods of country 1 towards goods of country 2, but if nevertheless the traditional advantages of a greater common currency area are large enough to warrant the move towards monetary union than another form of policy adjustment must be used. One possibility is that the establishment of a European Monetary Union must go hand in hand with the establishment of a European Federal Fiscal Authority whose task it is to transfer income from country 2 to country 1 when there are such shifts in preferences (e.g., Sachs and Sala-i-Martin, 1989). It is a pity that the Delors Report does not contain any recommendations for the establishment of a European Federal Fiscal Authority, for without this regional imbalances induced by shifts in preferences may persist.

However, when asymmetric shocks correspond to adverse supply shocks to country 1, the case for a regime of floating exchange rates is a bit more subtle. The reason is that such a shock leads both to unemployment and to higher prices and a lower real income in country 1, so that on the one hand a depreciation of the currency is required as this leads to more employment but on the other hand an appreciation of the currency is required to depress

prices and raise real income. It is therefore not clear whether a depreciation or an appreciation of the currency is desirable from a welfare point of view. Table 2 shows the effects of an adverse supply shock in one of the two countries under the alternative exchange-rate regimes. The main point to note is that in a regime of floating exchange rates the excess demand for home goods induces an immediate appreciation of the exchange rate to its new long-run value[3], so that the fall in real income is cushioned compared with the outcome under monetary union. The counterpart is that the other country suffers a greater fall in real income. Of course, the falls in employment and output are accelerated whilst the other country enjoys a temporary increase in employment and output as a result of the appreciation of the exchange rate. Hence, in the face of an adverse supply shock, a monetary union copes better with unemployment than with real income[4]. The reason is that a monetary union leads to an expansion of the money supply at home and a contraction abroad. As far as the European Monetary System is concerned, Table 2 shows that an adverse supply shock in Germany leads to a much sharper fall in German employment than the fall induced in, say, French employment by a French supply shock. In addition, a German supply detoriation leads to unemployment in the rest of Europe whilst an adverse supply shock in the rest of Europe leads to over-employment in Germany. The reason is that in the first case the central banks of the rest of Europe defend their currencies by buying them up and tightening their monetary policy whilst in the latter case the central banks of the rest of Europe prevent their currencies from appreciating by buying Deutschemarks and loosening their monetary policy. The adverse effects on real incomes are symmetric, because the greater increase in French wages arising from a French shock is exactly off-set by less of a fall (actually an increase) in German wages so that the effect of a French supply shock on the real exchange rate is exactly the opposite of the effect of a German supply

---

[3] This is a general result, which arises because $\Delta w(\infty)=\Delta w^*(\infty)=\lambda\Delta i(\infty)$ implies that e must jump immediately to its new steady state. Also, see equation (28).

[4] This is exactly the opposite to what happens under a shift of preferences from home to foreign goods, because then the depreciation of the currency that occurs under a float softens the adverse effects on unemployment but leads to a further fall in real income.

shock[5].

Table 3 presents the non-cooperative and cooperative policy responses to an idiosyncratic supply detoriation under the alternative exchange-rate regimes. As far as average welfare is concerned, the welfare ranking in decreasing order of magnitude is a cooperative float, a cooperative monetary union or a cooperative European Monetary System, a non-cooperative European Monetary System, a non-cooperative float and a European Monetary Union. European Monetary Union performs so badly because appreciation of the exchange rate can no longer be used as an instrument to remove the excess demand for home goods. As a result the greater expansion of the home money supply leads to a larger increase in prices, a larger fall in (and overshooting of) real income and less unemployment than in the regimes where the exchange rate is allowed to appreciate. Hence, the occurrence of idiosyncratic shocks make monetary union an undesirable regime. There is not much difference between a cooperative and a non-cooperative float. In the former case the home money supply expands somewhat more, which leads to somewhat smaller output losses and higher losses in real income. As far as the European Monetary System is concerned, when Germany is hit by a supply shock, it expands its money supply by more than when the rest of Europe is hit by a supply shock, so that this leads to smaller output losses and larger losses in real income for Germany.

7. Concluding remarks

Both a standard two-country Mundell-Fleming model and a similar model extended to allow for wage-price and exchange-rate dynamics have been used to compare the responses of monetary policy and the effects on welfare under a regime of floating exchange rate, an asymmetric regime of managed exchange rates (such as the European Monetary System) and a symmetric regime of irrevocably fixed exchange rates (such as European Monetary Union). It has been assumed that capital markets are fully liberalised and that there is no

---

[5] This is a general result, which arises because it is easy to show that the effects of $s-s^*$ on $w-w^*$, c, $m-m^*$ and $y-y^*$ are the same under monetary union as under the European Monetary System.

labour mobility. In the face of a common adverse demand shock monetary policy expands to ensure full employment. There is no conflict over the cost of living, so that there is no need for international policy coordination under any of the three regimes. In the face of a change in preferences away from the goods of country 1 towards the goods of country 2, monetary union performs very badly compared with the other two regimes because the exchange rate is not able to depreciate. This is the main reason why, when there are rigidities in labour markets, one might advocate the establishment of a Federal Fiscal Authority in conjunction with the establishment of a Federal Monetary Authority. Its task should, in the presence of such a shock, be to transfer income from country 2 to country 1. It is a pity that the Delors Report did not advocate the establishment of such a Federal Fiscal Authority.

In the face of a common adverse supply shock, however, a monetary union performs much better than a regime of floating exchange rates. The reason is that the competitive, futile attempts to appreciate the currency and export inflation are avoided. A non-cooperative float then leads to too tight monetary stances, too high interest rates and too much unemployment. Under the European Monetary System the central banks of Europe other than the Bundesbank manage to appreciate their currencies vis-à-vis the Deutschmark and thus disinflate away some the adverse consequences of a common supply shock. Because Germany suffers a large loss in real income, it experiences a greater welfare loss than the rest of Europe. In addition, Germany is worse off under the EMS than under monetary union whilst the rest of Europe is better off. This may be one of the few reasons why Germany may be keen to join a more symmetric European System of Central Banks. The rest of Europe is better off than with a non-cooperative float, but Germany is only better off when countries care relatively more about the cost of living than unemployment. In the face of an idiosyncratic supply shock, a monetary union performs, in terms of the average welfare loss, much worse than either a cooperative or a non-cooperative regime of floating or managed exchange rates. The reason is of course that the currency cannot appreciate in response to the excess demand for goods.

The move towards monetary union in Europe is thus much more justified in the presence of common shocks than in the presence of idiosyncratic shocks. This means that the establishment of Federal Fiscal Authority may

be essential in order to off-set idiosyncratic shocks. However, a first-best solution is to make sure that labour markets clear immediately or to make sure that factor (in particular labour) mobility is very high throughout Europe[6]. Unfortunately, labour markets do not function properly and cultural and language barriers prevent a high degree of labour mobility so that the move towards monetary union must be accompanied by the appropriate design of a fiscal institution at a European level in order to compensate for giving up monetary and exchange-rate policy as an independent instrument of economic policy. The other advantages of moving towards full monetary union in Europe can then be obtained as well: reduction in exchange-rate risk; less speculative capital flows and no more speculative attacks and thus the liberalisation of capital markets throughout Europe will be facilitated; saving on foreign-exchange reserves; a greater weight in negotiations about the global management of exchange rates with Japan and the US; the efficiency of a single money as a unit of account and store of value; weakening of the German hegemony in monetary policy may mean that Germany is more likely to have a looser fiscal stance, carry its full burden of fighting unemployment in Europe and be "a locomotive engine of growth"; less transaction and information costs; better monetary discipline and lower inflation rates (e.g., van der Ploeg, 1989a).

Two problems then remain. The first problem is that the presence of a large black economy in southern Europe justifies a higher optimal inflation tax for southern Europe than for northern Europe and thus justifies a crawling peg between southern and northern Europe (e.g., Dornbusch, 1988; Canzoneri and Rogers, 1988). However, it can be argued that countries with a large public nominal debt, such as Italy, have a big temptation to use surprise inflation to erode the real value of debt which, as the private sector anticipates this, leads to higher inflation rates in equilibrium (Gross, 1988). A clear commitment to peg the exchange rate to a low-inflation common currency area eliminates this inefficiency and may thus be optimal, despite a reduction in seigniorage revenues. The second problem is

---

[6] It also helps to make the move towards monetary union a success when countries have a high proportion of traded goods in domestic output, when countries have a high degree of product diversification, when countries have a high degree of financial integration, when countries have similar optimal inflation rates, and when countries have a high degree of policy and political integration (Ishiyama, 1975).

that, even when the countries of a monetary union are hit by a common adverse supply shock, there may be potential advantages associated with international coordination of fiscal policies so that appropriate supra-national institutions must be founded in order to ensure that this happens (Cohen and Wyplosz, 1989; van der Ploeg, 1989b). This need arises **either** when a European System of Central Banks is independent and is not willing to use the European money supply for stabilisation purposes and thus fiscal policy must be called upon **or** when the countries forming a European Monetary Union strategically interact with the United States. The latter situation arises, because Europe's trade balance determines its real exchange rate vis-à-vis the United States and thus effectively is a public good and its provision may in the absence of international coordination of fiscal policies be inefficient[7].

References

Basevi, Giorgio and Francesco Giavazzi, 1987, Conflicts and coordination in the European Monetary System, in Alfred Steinherr and Daniel Weiserbs, eds., Employment and growth: Issues for the 1980's (Martinus Nijhoff, Dordrecht).

Buiter, Willem H. and Richard C. Marston, eds., 1985, International economic policy coordination (Cambridge University Press, Cambridge).

Canzoneri, Matthew B. and Carol A. Rogers, 1988, Is the European Community an optimal currency area? Tax smoothing versus the cost of multiple currencies, mimeo, Georgetown University, Washington, D.C.

Cohen, Daniel and Charles Wyplosz, 1989, The European Monetary Union: An agnostic evaluation, discussion paper No. 306, Centre for Economic Policy Research, London.

---

[7] For example, in the face of a common adverse supply shock, each country attempts to get the other country to accept more of an increase in unemployment in order to achieve the appreciation of the European currency that is desirable for both countries. It follows that in a non-cooperative outcome not enough action is taken relative to the cooperative outcome.

Delors Committee, 1989, Report on economic and monetary union in the European Community, Committee for the study of economic and monetary union.

Dornbusch, Rudiger, 1988, The European Monetary System, the dollar and the yen, in Francesco Giavazzi, Stefano Micossi and Marcus Miller (eds.), The European Monetary System (Cambridge University Press, Cambridge).

Giavazzi, Francesco and Alberto Giovannini, 1989a, Limiting exchange rate flexibility: The European Monetary System (Cambridge University Press, Cambridge).

Giavazzi, Francesco and Alberto Giovannini, 1989b, Monetary policy interactions under managed exchange rates, Economica, 56, 222, 199-214.

Gross, Daniel, 1988, Seigniorage versus EMS discipline: some welfare considerations, working document No. 38, CEPS, Bruxelles.

Ishiyama, 1975, The theory of optimum currency areas: A survey, IMF Staff Papers, 344-383.

Kenen, Peter B., 1987, Global policy optimization and the exchange-rate regime, Journal of Policy Modeling, 9, 1, 19-63.

Miller, Marcus H. and Mark Salmon, 1985, Policy coordination and dynamic games, in Buiter and Marston (eds.).

Mundell, Robert A., 1968, International economics (MacMillan, New York).

Oudiz, Gillez and Jeffrey Sachs, 1984, Macroeconomic policy coordination among the industrial economies, Brookings Papers on Economic Activity, 1, 1-75.

Oudiz, Gillez and Jeffrey Sachs, 1985, International policy coordination in dynamic macroeconomic models, in Buiter and Marston (eds.).

Ploeg, Frederick van der, 1988, International policy coordination in interdependent monetary economies, Journal of International Economics, 25, 1-23.

Ploeg, Frederick van der, 1989a, Towards monetary integration in Europe, in Wetenschappelijke Raad voor het Regeringsbeleid, De Europese monetaire integratie: vier visies, V66 (SDU Press, The Hague).

Ploeg, Frederick van der, 1989b, Fiscal aspects of monetary integration in Europe, discussion paper No. 340, Centre for Economic Policy Research, London.

Ploeg, Frederick van der and Anton J. Markink, 1989, Dynamic policy games in linear models with rational expectations of future events: A computer package, mimeo, CentER for Economic Research, Tilburg University.

Rogoff, Kenneth, 1985, Can international monetary policy cooperation be counterproductive?, Journal of International Economics, 18, 199-217.

Sachs, Jeffrey D. and Xavier D. Sala-i-Martin, 1989, Federal fiscal policy and optimum currency areas, mimeo, Harvard University, Cambridge, MA.

Table 1: Policy responses to a common adverse supply shock ($s=s^*=1$) under alternative exchange-rate regimes

Regime / Variable	No Policy	FLOAT: No pre-commitm.	FLOAT: pre-commitm.	EMS Germany	EMS rest of Europe	EMU
Output:						
0	-0.500	-0.501	-0.557	-0.636	-0.719	-0.636
5	-0.857	-0.726	-0.846	-0.774	-0.829	-0.774
∞	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
loss	36.840	34.041	35.972	34.565	35.824	34.565
Real income:						
0	-1.0	-1.0	-1.0	-1.045	-0.955	-1.0
5	-1.0	-1.0	-1.0	-1.029	-0.971	-1.0
∞	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
loss	40.0	40.0	40.0	40.833	39.188	40.0
Nominal wage rate:						
0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.357	0.470	0.329	0.362	0.277	0.362
∞	0.5	1.043	0.682	0.955	0.708	0.955
Nominal exchange rate:						
0	0.0	0.0	0.0	0.180	-0.180	0.0
5	0.0	0.0	0.0	0.203	-0.203	0.0
∞	0.0	0.0	0.0	0.246	-0.246	0.0
Nominal money supply:						
0	0.0	-0.001	-0.057	-0.136	-0.219	-0.136
5	0.0	0.244	-0.017	0.088	-0.052	0.088
∞	0.0	0.543	0.182	0.455	0.208	0.455
loss	0.0	8.832	0.771	5.418	1.126	5.418
Real interest rate:						
0	0.125	0.125	0.139	0.164	0.175	0.159
5	0.214	0.181	0.211	0.197	0.204	0.194
∞	0.25	0.25	0.25	0.25	0.25	0.25
Welfare loss:	76.840	75.807	76.126	76.482	75.237	75.649

Parameters: $\bar{\sigma}=1.0$; $\bar{\delta}=0.375$; $\gamma=0.75$; $\lambda=2.0$; $\varphi=0.25$; $\alpha=0.25$; $\vartheta_1=1.0$; $\vartheta_2=0.2$; $\rho=0.025$

Notes: (i) International policy coordination under a FLOAT (with or without credibility) and under the EMS yield the same outcomes as under EMU; the table presents the non-cooperative (Nash-Cournot) outcomes under FLOAT and EMS.

(ii) The losses for output, real income and the money supply refer to the discounted squared deviations from desired values.

Table 2: Effects of an idiosyncratic adverse supply shock under alternative exchange-rate regimes

Variable	Regime	FLOAT (s=1)	EMS (s=1)	EMS (s*=1)	EMU (s=1)
y:	0	-0.75	-0.135	-0.365	-0.442
	5	-0.928	-0.583	-0.274	-0.756
	∞	-1.0	-1.0	0.0	-1.0
y*:	0	0.25	0.25	-0.75	-0.058
	5	0.072	0.072	-0.928	-0.101
	∞	0.0	0.0	-1.0	0.0
ω:	0	-0.417	-0.75	-0.25	-0.75
	5	-0.417	-0.604	-0.396	-0.604
	∞	-0.417	-0.417	-0.583	-0.417
ω*:	0	-0.583	-0.25	-0.75	-0.25
	5	-0.583	-0.396	-0.604	-0.396
	∞	-0.583	-0.583	-0.417	-0.583
w:	0	0.0	0.0	0.0	0.0
	5	0.178	0.763	-0.406	0.471
	∞	0.25	1.583	-1.083	0.917
w*:	0	0.0	0.0	0.0	0.0
	5	0.178	0.178	0.178	-0.114
	∞	0.25	0.25	0.25	-0.417
e:	0	-1.333	0.0	0.0	0.0
	5	-1.333	0.0	0.0	0.0
	∞	-1.333	0.0	0.0	0.0
m:	0	0.0	0.615	-0.615	0.308
	5	0.0	0.930	-0.930	0.465
	∞	0.0	1.333	-1.333	0.667
m*:	0	0.0	0.0	0.0	-0.308
	5	0.0	0.0	0.0	-0.465
	∞	0.0	0.0	0.0	-0.667

Parameters: $\bar{\sigma}$=1.0; $\bar{\delta}$=0.375; γ=0.75; λ=2.0; φ=0.25; α=0.25

Note: Abroad corresponds to Germany and home to the rest of Europe.

Table 3: Policy responses to an idiosyncratic adverse supply shock under alternative exchange-rate regimes

Variable	Regime	FLOAT Nash (s=1)	FLOAT Pareto (s=1)	EMS Nash (s=1)	EMS Nash (s*=1)	EMU fixed e (s=1)	EMU flexible e (s=1)
y:	0	-0.705	-0.765	-0.786	0.067	-0.510	-0.749
	5	-0.873	-0.838	-0.863	0.034	-0.714	-0.837
	∞	-1.0	-10.	-1.0	0.0	-1.0	-1.0
	loss	36.505	35.704	36.470	0.015	33.591	35.749
y*:	0	0.148	0.129	0.095	-0.732	-0.126	0.113
	5	0.027	0.064	0.059	-0.833	-0.060	0.063
	∞	0.0	0.0	0.0	-1.0	0.0	0.0
	loss	0.031	0.053	0.042	35.870	0.049	0.048
ω:	0	-0.498	-0.408	-0.481	-0.474	-0.75	-0.492
	5	-0.472	-0.472	-0.459	-0.512	-0.604	-0.471
	∞	-0.417	-0.417	-0.417	-0.582	-0.417	-0.419
	loss	7.685	7.729	7.456	12.507	9.358	7.680
ω*:	0	-0.502	-0.520	-0.519	-0.526	-0.25	-0.508
	5	-0.528	-0.528	-0.541	-0.488	-0.396	-0.529
	∞	-0.583	-0.583	-0.583	-0.418	-0.583	-0.582
	loss	12.667	12.603	12.946	7.839	11.275	12.670
w:	0	0.0	0.0	0.0	0.0	0.0	0.0
	5	0.240	0.248	0.216	0.061	0.473	0.255
	∞	0.599	0.766	0.602	0.106	1.144	0.746
w*:	0	0.0	0.0	0.0	0.0	0.0	0.0
	5	0.089	0.114	0.095	0.267	-0.111	0.107
	∞	0.083	0.189	0.25	0.705	-0.189	0.207
e:	0	-1.009	-1.078	-1.076	0.897	0.0	-1.033
	5	-0.959	-0.978	-1.044	0.841	0.0	-0.968
	∞	-0.818	-0.757	-0.981	0.735	0.0	-0.797
m:	0	0.035	-0.053	-0.036	-0.183	0.240	0.001
	5	0.108	0.147	0.103	-0.154	0.509	0.168
	∞	0.349	0.516	0.352	-0.144	0.894	0.496
	loss	3.109	6.649	3.292	0.828	24.811	6.487
m*:	0	-0.093	-0.084	-0.155	0.019	-0.376	-0.138
	5	-0.125	-0.059	-0.096	0.184	-0.421	-0.081
	∞	-0.167	-0.061	0.0	0.455	-0.439	-0.041
	loss	0.882	0.096	0.111	5.851	7.643	0.113
Welfare		44.811	44.763	44.584	12.687	47.910	44.726
Welfare*		12.874	12.676	13.011	44.879	12.853	12.740
Av. welfare		57.685	57.439	57.595	57.566	60.763	57.466

Parameters: $\bar{\sigma}$=1.0; $\bar{\delta}$=0.375; γ=0.75; λ=2.0; φ=0.25; α=0.25; ϑ_1=1.0; ϑ_2=0.2; ρ=0.025.

Notes: (i) The EMS outcomes under international policy coordination correspond to the EMU outcomes under international policy coordination and under floating exchange rates. The FLOAT outcomes assume that central banks can pre-commit to their announced monetary policies.

(ii) The losses for output, real income and the money supply refer to the discounted squared deviations from desired values.