Interpreting the ERM Crisis: Country-Speci…c and Systemic Issues

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January 1996
Revised May 1996

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1 Introduction

Since 1979, the Exchange Rate Mechanism (ERM) has represented the cornerstone of monetary policy strategies in Europe, and the most ambitious experiment in international monetary and exchange rate cooperation of the post-Bretton Woods era. The nature of the ERM has not remained unchanged over time. Originally intended as a system of …xed but (frequently) adjustable rates with limited international capital mobility, it was only in the second half of the 1980s that the ERM became the "hard" ERM , a regime of stable and narrow currency bands defended by coordinated intervention among central banks, virtually without exchange controls.

Until the fall of 1992, the satisfactory performance of the new ERM was a key factor underlying the general appeal of a further transformation of the system toward complete monetary harmonization, and eventual uni…cation. Starting in early 1992, however, a sequence of adverse developments of increasing severity undermined the whole process towards European Monetary Union (EMU). The crisis and revamping of the ERM between 1992 and 1993 represents the key event in the recent monetary history of Europe — one whose origins, consequences and implications are still at the core of the current academic and political debate, both in Europe and elsewhere.

The literature has provided several complementary interpretations of the ERM crisis. Possibly the most popular one is based on the policy con‡ict stemming from the internal reuni…cation process in Germany and the policy mix adopted in that country during the early 1990s. Other explanations of the collapse in terms of the behavior of fundamentals focus on persistent divergent performances of national price or unit cost levels — presumably re‡ecting divergent national monetary and …scal policies during the "hard" ERM years —; the liberalization of international …nancial capital movements under the Single Act; and the perceived change in national policy-makers' commitment to …xed exchange rates after the results of the …rst Danish referendum in June 1992. Finally, the role of self-ful…lling speculative attacks, triggered by sudden, and essentially arbitrary, expectations shifts in the …nancial markets, has been emphasized in recent interpretations of the collapse of the ERM.

In the present stage of international debate on EMU, when European policy makers are about to give shape to the future by (one hopes) drawing lessons from the experience of the past, an incorrect or even just incomplete interpretation of the 1992-93 events may be socially, and politically, costly.

Do the existing theories, individually or collectively, o¤er a reasonable picture of the ERM crisis and point to a su¢ciently comprehensive list of factors to be taken into account?

In our view, most interpretations of the 1992-93 events miss the following crucial element: the ERM crisis has been the crisis of an exchange rate system, rather than the collapse of a collection of unilateral pegs individually pursued by a number of countries. The existing interpretive schemes typically focus on the adjustment problem of a representative country, facing an exogenous shock that undermines the stability of the current exchange rate parity against the center country. The thesis we develop in this contribution is that the conclusions reached within such framework may be incomplete or misleading, since they ignore the key role played by structural policy spillovers among European countries, and overlook the e¤ects of coordination (or lack thereof) of monetary and exchange rate policies among the countries making up the periphery of the system. In contrast to an approach that focuses exclusively on country-speci…c issues, we argue that a systemic view is ultimately able to unravel more coherently, and more convincingly, the "puzzles" of the ERM crisis.

The paper is structured in three parts. The …rst part (Section 2) presents an overview of the analysis, summarizing our main results. The second part (Sections 3-5) is devoted to an analytical review of the current theoretical literature, focusing on the role of domestic credibility in a unilateral peg framework. The international dimensions of the equilibria, and their implications for the European events, are explored in the third part (Sections 6-9).

Section 3 provides a simple analytical framework, able to encompass — both technically and intellectually — the recent literature on currency crises, while developing it by bringing out the decisive role of the strategic interactions among national policy makers in a multi-country monetary and exchange rate game. Section 4 characterizes the domestic equilibrium on a theoretical level, while the following section uses our results to review several interpretations of the ERM crisis.

Sections 6 through 9 develop the analysis of an exchange rate system crisis as an international policy game. Section 6 describes the international dimension of the non-cooperative (Nash) equilibrium. The alternative to Nash is cooperation, restricted in a way that, in our view, captures the relevant institutional and historical features of the ERM and is especially suitable to describe the international policy con‡ict at the time of the crisis (Section 7). Section 8 compares cooperative and Nash equilibria and provides an assessment of the role of policy coordination in a currency crisis. Section 9 interprets the 1992-93 crisis in the framework of our Center-Periphery model.

A …nal section recapitulates the main issues raised in the paper, drawing some lessons for the current debate on the monetary future of Europe.

2 An overview of the analysis

2.1 Theory...

It is helpful to anticipate and synthesize in an opening section the main features of our theoretical framework. We model the ERM as a system consisting of a set of Periphery countries that peg their currencies against the currency of the price-stabilizing Center country. Our construction conforms to the 'consensus' view (at the time of the crisis) of the ERM as a disin‡ation mechanism, where the exchange rate against the D-mark is the nominal anchor for Periphery countries.

In our model, the Center has an uncompromising attitude towards its own price stability goal, and the policy-makers' objective function exhibits no in‡ationary bias. These characteristics qualify the Center as the natural candidate to receive the mandate of guaranteeing price stability (but not necessarily monetary stability) in the system. Conversely, the in‡ation-prone Periphery countries consider …xed exchange rates as an intermediate target toward price stability. However, policy-makers' commitment in the Periphery is only imperfectly credible, and market participants perceive the abandonment of the peg as a possible policy option in the presence of external shocks.

With the German uni…cation scenario in mind, we assume that the source of tension in the system is a large, asymmetric disturbance in the form of a demand (e.g., 'IS') shock in the Center, generating pressures for an e¤ective real appreciation of the currency of this country. In such a situation, the Periphery as a whole would bene…t from a monetary expansion by the Center, which would absorb at least part of the domestic demand surge and lower interest rates in the system. However, the resulting level of internal in‡ation would be unacceptable to the authorities in the Center. The Center would of course bene…t from a realignment in the system, that would o¤set the original demand shock, but a realignment would entail high reputation and credibility costs for the policy makers in the Periphery countries.

Even though the monetary authorities of the Center are unwilling to jeopardize their internal nominal targets by cooperating with the Periphery, Periphery countries have a welfare incentive to coordinate their monetary policies among themselves, internalizing their reciprocal spillovers (that is, the impact of domestic policies on other Periphery countries' in‡ation

and employment). Coordination, however, requires an e¤ective enforcement mechanism (to prevent unilateral deviations from the agreement) that may not be available to the Periphery. Also, there may be lack of consensus and agreement on how the costs and bene…ts from Periphery-wide policies — such as a generalized exchange rate realignment against the Center — should be distributed among the individual Periphery countries.

In addressing the issue of feasibility of intra-Periphery cooperation, we argue that, based on the European experience, special weight should be given to a principle of national horizontal equity. The principle states that national authorities accept to cooperate only to the extent that no country would excessively bene…t or lose from the common policy more — in relative terms — than the others. A national horizontal equity constraint thus implies that no country is willing either to bear a disproportionate share of the costs of a coordinated realignment, or to accept an unfair distribution of its bene…ts, even when the corresponding exchange rate policy would be e¢cient for the system as a whole.

Of course, national horizontal equity is, in principle, consistent with a very large set of Community-wide policy decisions — and realignment schemes, — provided countries can use appropriate side-payments to compensate the losers (if only in relative terms) from such decisions. However, international transfers contingent on asymmetric realignments with selective devaluations tend to be politically questionable, and di¢cult to implement. It does not come as a surprise that, in the history of the ERM, there is no evidence that they ever represented an institutional reality. Thus, in our model, while postulating national horizontal equity, we also rule out side-payments among countries.

We consider two scenarios characterizing the possible policy responses of the Periphery countries to the Center demand shock. In the …rst scenario, Periphery countries coordinate their exchange rate policies – subject to a national horizontal equity constraint without side-payments – so as to maximize a common social welfare function. In the alternative scenario, there is no cooperation, and each country unilaterally maximizes its own objective function.

Our model shows that, given a realistic hypothesis about the sign of international policy spillovers (expansionary monetary policy in any Periphery country contributes to lower real interest rates in the system as a whole, and causes a real appreciation of the currencies of all other Periphery countries), the optimal coordinated response by the Periphery is a set of small devaluations by a large number of countries. If, instead, the Periphery countries do not coordinate their monetary and exchange rate policies against the Center, we will observe large devaluations by a small number of countries. In the

aggregate, coordinated exchange rate policy is generally more expansionary for the system as a whole than uncoordinated policy actions.

The intuition underlying these results is rooted in the international spillovers of domestic monetary policy. The devaluation of one country (say, Italy) affects the other Periphery countries through two channels. First, a fall in the price of imports from Italy decreases CPI in‡ation in the rest of the system. Second, by devaluing, Italy contributes to a loosening of the stance of ERM-wide monetary policy, decreasing the interest rate in real terms and therefore boosting aggregate demand and employment in the system. In the presence of such spillovers, if a coordinated policy response requires a realignment of the Periphery as a whole vis-à-vis the Center, the magnitude of the realignment will be increasing in the magnitude of the externality: with positive externalities, monetary cooperation calls for "doing more" as regards exchange rate policy.

From the vantage point of each single Periphery country, however, "doing more" does not translate into a large devaluation of its currency against the Center. In fact, because of the national horizontal equity constraint (the expression of the requirement of political fairness in the Periphery), the coordinated response would likely consist of a realignment scheme including many currencies. Given the strong impact that such a joint devaluation has on interest rates, the individual devaluation rate need not be high for domestic stabilization purposes.

Conversely, in a scenario without cooperation, provided that some countries devalue and therefore lower the real interest rates in the system, some other countries may avoid a realignment altogether. In equilibrium, the average monetary stance is less expansionary than in the coordinated scenario, because the subset of the devaluing countries has only a limited impact on the system-wide equilibrium real interest rate. Nonetheless, for this very reason, if a country abandons the peg its individual devaluation rate turns out to be "excessively" high.

2.2 ... and policy

What is the contribution of a systemic model of currency crises to the understanding of the 1992-93 events? Consider again the explanation stressing the role of the German uni...cation shock. According to this view, the ERM crisis stems from the con‡ict between a Center-country that is unwilling to bear the in‡ationary consequences of the uni...cation, and the Periphery-countries that dislike the idea of a nominal realignment but are not willing to sustain the costs of a de‡ation. It is worth pointing out that such a policy con‡ict was apparent on several occasions, an important example being the European

meeting at Bath, on September 5 and 6, 1992.[1]

Taking this con‡ict as a datum, our analysis picks up from where the other contributions in the literature generally stop. By itself, in fact, the identi…cation of an important source of tensions calling into question the existing ERM parities does not tell us much about the likely modalities of adjustment of these parities. To clarify this point, recall that, in our analysis, the optimal coordinated response by the Periphery to the aggregate demand shock in the Center country is a set of small devaluations by a large number of Periphery countries. Indeed, during the weekend preceding the Lira devaluation, Germany and Italy formulated a realignment scheme that entailed a generalized, small realignment of all ERM currencies against the D-mark: the scheme had a D-mark nominal revaluation by 3.5%, coupled with a 3.5% devaluation of the lira – so that the lira would have been devalued by 7% against the D-mark.

If …nancial agents believed that the Periphery countries acted cooperatively, their expectations would be based on the forecasted generalized, small realignments. Empirical evidence supports this theoretical prediction: although the credibility of the ERM was falling in August 1992, all indicators of devaluation expectations — such as interest rate di¤erentials, forward premiums, and average forecasts based on survey data — were by no means large by historical standards.

In our interpretation, the realignment on September 14, 1992, gave the private sector a strong signal about the degree of policy coordination in the system. In our view, it was the devaluation of the lira (or, rather, the fact that it was only the lira that was devalued that day) that revealed to the markets what kind of strategic game the Central Banks were playing. What had been thought of as an international monetary system, turned out to be nothing more than a collection of individual, unilateral pegs against the D-mark.

What are the implications for the behavior of private markets? Once again, recall that restoring equilibrium without coordination requires large devaluations by a subset of countries. Presumably, in the absence of cooperation, the equilibrium depreciation of the lira should have been higher than the initial 7% implemented on September 14, 1992: in fact, 7% was the same …gure that had been proposed in the context of a general realignment two days earlier, which would have had all countries joining Italy in devaluing their currencies. Also, there was a legitimate question as to whether other countries should also have devalued in the new non-cooperative equilibrium. As market participants analyzed the implications of the new policy scenarios, many currencies must have appeared as potential candidates to sizable, non-cooperative devaluations. In our theoretical model, while the number

of countries involved in a non-cooperative realignment is well de…ned, which countries devalue cannot be determined. The 1992-93 waves of speculative attacks in Europe, apparently regardless of the performance of macroeconomic fundamentals across countries, were the logical outcome of such conclusions.

Could have the ERM been saved by a joint devaluation, implementing some scheme similar to the German-Italian proposal? Our model points out the possibility that no coordinated realignment might have been politically acceptable under the national horizontal equity constraint. In other words, it is possible that there existed no common realignment scheme that would have compensated for the common loss of anti-in‡ationary credibility. Under these circumstances, countries could have only "coordinated" on a painfully de‡ationary defense of the existing parities. Clearly, insofar as uncoordinated behavior loosens up the average monetary policy in the system (through large, uncoordinated devaluations by a few Periphery countries), it is both individually and collectively rational to switch from (constrained) cooperation to non-cooperation.

The model o¤ers an analytical key to interpret the evolution of European exchange rates from September 1992 onward, provided we de…ne the Center to include both Germany and other countries, like the Netherlands, that have long delegated their monetary policies to Germany. Possibly, in the period under consideration, France has acquired the special position of belonging to the (soft) "Core" of the system: a country subject to large-scale speculative attacks, like the rest of the Periphery, but not succumbing to them, thanks to many episodes of strong and e¤ective monetary cooperation (and massive support from Germany). Outside the "Core", the exit of the lira and the pound from the ERM, recurrent speculative attacks and devaluations since September 1992 were to a large extent the re‡ection of each country's attempt to restore macroeconomic equilibrium in a new European Monetary System (EMS) su¤ering from the loss of its systemic structure and nature.

3 A Center-Periphery model of currency crises

3.1 An introduction to the model

The interpretation summarized above is based on a general model of currency crises in a multi-country setup. To emphasize both links with and departures from the existing literature, we cast our analysis within the familiar framework of an international monetary policy game, adopting its standard conventions.[2] We believe that the novelty of our approach, namely a systemic analysis highlighting the role played by international spillovers

and strategic policy interactions, is more likely to stand out when presented against a familiar background.

Notably, in specifying our model, we adopt the view according to which a …xed exchange rate policy facilitates the process of domestic disin‡ation and helps strengthen the reputation of the domestic policy, by "importing" credibility from the center. Needless to say, in the post-crisis literature the idea of any e¤ectiveness of the ERM as a 'commitment technology' has met with increasing skepticism. Yet, from the mid-Eighties until the 1992-93 crisis, the anti-in‡ationary discipline of an exchange rate peg as a nominal anchor has provided the most common economic argument in favor of the ERM.[3] To the extent that it captures the conventional view of the ERM shared by both public and private agents in the months preceding the crisis, such an approach provides the appropriate setup with which to analyze the formation of market expectations, as well as to interpret the unfolding of the 1992-93 events.

In our framework, the economy consists of $N + 1$ countries, the …rst N of which represent the Periphery of the system, while the last is the Center. All countries in the system are symmetric as regards technology and private sector decision rules, including those characterizing labor market behavior. However, there are crucial macroeconomic dissimilarities between Center and Periphery; speci…cally, the Center has three unique characteristics. First, it provides a nominal anchor for the system as a whole by targeting the level, rather than the rate of growth, of the price level. Second, there is no discrepancy between the target level of output and potential (full-employment) output, so that no in‡ationary bias (à-la-Kydland-Prescott/Barro-Gordon) a¤ects its economy in a time-consistent equilibrium. Third, it is assumed that all countries in the Periphery trade real goods and services exclusively with the Center, that is, intra-Periphery trade is negligible. No such restriction is imposed on trade in …nancial claims.

At a …rst sight, the third assumption may appear very unrealistic; after all, concerns with the competitive gap within the Periphery have been frequently raised by national policy-makers and by both import-competing and exporting sectors in Europe since the inception of the ERM, a¤ecting the determination of Community-wide exchange rate policies.[4] However, the assumption simply allows us to omit algebra-intensive but inessential considerations: the results we would obtain in a more complex setup would not signi…cantly alter the conclusions reached within our framework. For instance, one of the properties of our model is that a devaluation in a given Periphery country shifts global demand towards the country's products and causes a real appreciation in all other Periphery countries, the same qualitative result we would obtain in a model focusing directly on intra-Periphery

competitiveness.

In contrast to the Center, in the Periphery there is an in‡ationary bias in policy making. Due to the presence of such a bias, Periphery countries choose to reduce the scope for discretion in monetary policy by pegging their exchange rates against the currency of the Center. Such a policy would obviously be time-inconsistent, unless reneging on the commitment to maintain the announced exchange rate peg entails a loss of utility for the policy maker: the higher the opportunity cost of switching to a ‡oat, the higher the reliability of the commitment to a …xed exchange rate regime.

Our theoretical construction hinges on the impact of global shocks originating in the Center on the performance and the policies of the Periphery countries. Therefore, the only source of (exogenous) uncertainty that is explicitly modeled is an aggregate demand shock in the Center country — the German uni…cation shock. The emphasis on such a source of uncertainty is motivated by the stylized facts preceding the collapse of the ERM, in particular the demand boom associated with German uni…cation. Nonetheless, our setup could be easily extended to encompass currency substitution shocks or supply-side productivity disturbances.

3.2 The structure of the economy

The structure of the economy closely follows the literature on international policy games.[5] As the main features of our setup are well known, in what follows we will exclusively focus on a semi-reduced form of the model; a detailed description of the structural characteristics of the economy is presented in Appendix A-D. As regards notation, all variables other than interest rates are in natural logarithms. All Center variables are starred, while the Periphery countries are indexed with a subscript i, for $i = 1; 2; :::; N$. Unless otherwise explicitly stated, Greek letters (both lowercase and uppercase) refer to constant, positive parameters.

The …rst two equations of the model describe the levels of employment and CPI in the $i ¡ th$ Periphery country:

$$n_{i;t} = \frac{1}{®_2} [s_{i;t} ¡ w_{i;t} + p^{¤}_t ¡ À_{i;t}] \tag{1}$$

$$q_{i;t} = ®_0 n_{i;t} + w_{i;t} + \bar{À}_{i;t} \tag{2}$$

where $n_{i;t}$ is the level of employment in the $i ¡ th$ Periphery country at time t; $s_{i;t}$ is the nominal exchange rate (domestic currency per unit of Center currency); $w_{i;t}$ is the domestic nominal wage prevailing at time t; $q_{i;t}$ is the domestic CPI in country i; $p^{¤}_t$ is the GDP de‡ator in the Center country.

Last, the variable $À_{i;t}$ is a country-speci…c shock, whose characteristics will be analyzed below in detail.

The interpretation of these equation is straightforward. Consider expression (1) …rst. For given nominal wages, employment is increasing in the nominal exchange rate, as this implies a higher rate of monetary expansion and lower real wages. For a given exchange rate, employment is decreasing in the level of nominal wage, as this reduces domestic competitiveness. Ceteris paribus, employment and output increase with a monetary expansion in the Center which raises $p^¤_t$, boosting the demand for the Periphery countries' exports. In expression (2), the in‡ationary impact of a surge in domestic employment and a rise in nominal wages is self-explanatory.[6]

In the class of models under consideration, the timing of the decisions is the following. First, the money wage rate $w_{i;t}$ is set, before the shock and the response of the domestic central bank are observed by private agents. Wages are not renegotiated after the money supply is announced. Thus, wage contracts prevailing at time t are based on information available at time $t ¡ 1$: the economy is characterized by short-run (one-period) nominal wage rigidities. Second, the shock $À_{i;t}$ is observed and the central bank chooses the level of the domestic money supply. Under standard assumptions,[7] the rational-expectation wage rate is equal to the expected money supply

$$w_{i;t} = E_{t ¡ 1} m_{i;t} \tag{3}$$

(where $E_{t ¡ 1}$ denotes the expectation operator conditional on information available at time $t ¡ 1$) and the level of employment is equal to the domestic monetary innovation

$$n_{i;t} = m_{i;t} ¡ E_{t ¡ 1} m_{i;t} \tag{4}$$

Thus, for given wages, the semi-reduced form for the employment level is also a semi-reduced form for money supply. Also, the domestic de‡ator $p_{i;t}$ is equal to

$$p_{i;t} = w_{i;t} + ®n_{i;t} = (1 ¡ ®) E_{t ¡ 1} m_{i;t} + ®m_{i;t} \tag{5}$$

We can now provide a discussion of the domestic disturbance term $À_{i;t}$. As shown in Appendix D, the country-speci…c shock includes two components:

$$À_{i;t} ´ ²_t ¡ @®_1 \sum_{j \neq i} n_{j;t} + Án^¤_t A \tag{6}$$

The …rst component, indexed by $²_t$; a¤ects all Periphery countries symmetrically, as it depends on current and future anticipated disturbances to the aggregate demand of the Center country (e.g., the 'IS' shock).[8] The second

component of the country-speci…c shock (in brackets) depends – with a negative sign – on the monetary innovations (i.e. on the employment levels) of all the other countries in the system.

Intuitively, in equilibrium an increase in demand for the Center's output requires, ceteris paribus, a real e¤ective appreciation of the Center's currency against the Periphery. This can be achieved through (a) domestic in‡ation in the Center, (b) an appreciation of the nominal exchange rate of the Center against the Periphery, or (c) a generalized de‡ation in the Periphery. Under option (a), the demand boom in the Center would be absorbed internally and would not have signi…cant consequences in the Periphery: heuristically, the changes in ^2_t and $n^¤_t$ would o¤set each other in equation (6), leaving $À_{i;t}$ una¤ected everywhere in the Periphery.

If the Center is unwilling to tolerate the in‡ationary consequences of the internal demand boom, the shock is transmitted to the Periphery. Consider …rst the case in which the Periphery consists of one country only. Equation (2) shows that, for any given domestic monetary policy in the Periphery country (and thus, for any employment and GDP de‡ator level), the IS shock in the Center unambiguously leads to in‡ation in the Periphery. The mechanism is well known. As the demand boom in the Center raises the interest rates in the Center, capitals ‡ow from the Periphery to the Center. If the monetary authorities in the Periphery do not react to the fall in the demand for domestic currency, the equilibrium exchange rate depreciates in both nominal and real terms against the Center, and the CPI level in the Periphery increases (option b). However, the monetary authorities of the Periphery country can also accommodate the shock by decreasing its money supply and defending the exchange rate parity. The defense of the peg, as shown by eqn.(1), has a recessionary impact on the domestic economy (option c).

In the general case of $N > 1$ Periphery countries, eqn.(6) makes clear that — from the vantage point of each individual Periphery country — the impact of the shock originating in the Center depends not only on the policy response of the Center itself, but also on the monetary behavior of the rest of the Periphery. In other words, while the relevant shock $À_{i;t}$ is always "country-speci…c", it re‡ects the behavior of all the other countries in the system. If $®_1$ is positive — as we discuss below —, the role played by a monetary expansion in the rest of the Periphery is somewhat analogous to the role played by a monetary expansion in the Center. By bringing the e¤ective terms of trade of the Center closer to its equilibrium level, an expansion somewhere in the Periphery represents a "shock-absorber" for the rest of the system.[9]

3.3 Social welfare and commitment technology

The loss function of the policy maker in the $i-th$ Periphery country is defined as follows

$$\sum_{\tau=0}^{\infty} E_t \ell_{i;t+\tau} \tag{7}$$

where the single period loss function is

$$\ell_{i;t} \equiv \frac{1}{2}\left[(n_{i;t} - \hat{n}_i)^2 + \lambda(q_{i;t} - \hat{q}_{i;t})^2\right] + c_i I_{i;t} \tag{8}$$

$$I_{i;t} = \begin{cases} 0 \text{ if } s_{i;t} = \hat{s}_{i;t} \\ 1 \text{ otherwise} \end{cases} \tag{9}$$

$$\bar{q}_{i;t} = \bar{s}_{i;t} + \bar{p}_t^{\alpha} \tag{10}$$

The single period loss function ℓ_i in (8) is quadratic in the deviation of actual employment and CPI from their current target levels, $\hat{n}_i$ and $\hat{q}_{i;t}$ respectively. The target level of employment exceeds the rational-expectations equilibrium or "natural" level. As in this model the latter is normalized to zero, we have $\hat{n}_i > 0$. Following the standard conventions, such a parametrization of the model implies the presence of some exogenous (and unremovable) distortions in the Periphery labor market, that make the full-employment output level socially suboptimal. The well-known theoretical implication of the resulting conflict between public preferences and equilibrium constraints is that an equilibrium with full monetary discretion leads to a Pareto-dominated allocation, affected by an inflationary bias.

The target levels for prices and employment, as well as the exchange rate parity (indexed by $\hat{s}_{i;t}$) are known at time $t-1$, before wages are set. The target price level of the Periphery country (eqn.(10)) has two properties. First, as long as the exchange rate peg is maintained, the Center's price level target $\hat{p}_t^{\alpha}$ is also the Periphery's price level target.[10] Second, when the peg is abandoned, there is 'drift' in the Periphery's price level target: unlike the Center,[11] a Periphery country does not automatically try to recoup an inflation disappointment.

The positive constant c_i in eqn.(8) denotes some exogenously given welfare cost of abandoning the peg: country i's policy makers suffer a welfare loss equal to c_i when the current exchange rate deviates (no matter by how much) from the announced exchange rate parity. For our purposes, these costs are best understood as a proxy for the wide array of non-quantifiable political interests underlying the defense of a given exchange rate target, ranging from naked national chauvinism to fears of professional loss of prestige, reputation

and in‡uence; they may also re‡ect a widespread belief that exchange rate stability is a public good in its own right, quite apart from its anti-in‡ationary implications.

In our model, market participants take the existence of a commitment technology as a datum: the higher the degree of commitment by the policy authority to the defense of the peg, the higher the lump-sum costs c_i that the policy authority will "pay" if it abandons its announced target. An extremely high value of c_i implies that, regardless of internal and external circumstances, the policy authority will subordinate its other objectives to the defense of the current exchange rate. A negligible value signals that governments will always let the currency ‡oat or, equivalently, set it at the value most conducive to the achievement of its other objectives. Intermediate values can be rationalized in terms of escape clauses allowing for the possibility of realignments in the presence of speci…c contingencies, i.e. depending on the size of the shock hitting the domestic economy (Obstfeld [1991]).

For the Center country we posit a one-period social loss in the following form

$$`^{¤}_{t} = \frac{1}{2}\left[(n^{¤}_{t})^2 + ¾(p^{¤}_{t})^2\right] \tag{11}$$

In contrast to eqn.(8), note, …rst, that the Center country does not su¤er from an in‡ationary bias ($ħ^{¤}_{t} = 0$); second, the price level target is constant and normalized to zero ($þ^{¤}_{t} = 0$), that is, in‡ation does not lead to a rebasing of the price level target over time; third, the policy maker does not target any exchange rate parity (there are no …xed costs of reneging on an exchange rate commitment).

The Center country optimally (and credibly) pursues full employment while setting the domestic de‡ator equal to zero in each period. It can be easily veri…ed that the policy maker in the Center will be able to achieve a social …rst best by following the monetary rule

$$m^{¤}_{t} = 0 \tag{12}$$

that implies

$$n^{¤}_{t} = m^{¤}_{t} ¡ E_{t¡1}m^{¤}_{t} = 0 \tag{13}$$

in all periods. It also follows that $p^{¤}_{t} = w^{¤}_{t} = 0$.

It is worth emphasizing that, in our speci…cation, the loss function of the Center includes the domestic GDP de‡ator instead of the domestic CPI (that depends on the e¤ective real exchange rate against the Periphery), so that there is no strategic interaction between Center and Periphery as a whole. At a theoretical level, there is no compelling reason to introduce such asymmetry between Center and Periphery.[12] However, in our interpretation

of the 1992-93 events, we want to emphasize how a systemic crisis is related to the policy con‡ict within the Periphery, once the con‡ict between Center and Periphery is frozen in non-cooperative behavior. To highlight this feature of our setup, we cut the Gordian knot and choose to avoid any analysis of the Center-Periphery interactions. It turns out that, while permitting us to avoid a great deal of analytical complications, including the GDP de‡ator in (11) instead of the CPI does not a¤ect the results of our analysis in any substantive way.

3.4 International policy spillovers

As intra-Periphery externalities play a crucial role in our model, it is important to analyze their nature and implications in detail. Consider a monetary expansion in one Periphery country, indexed by j; which brings about a real depreciation of its currency against the Center.[13] The impact of such a monetary expansion on the economy of another (any other) Periphery country, indexed by $i \neq j$, can be split into two components of opposite sign, an expenditure-switching and an expenditure-changing e¤ect.

These e¤ects are best understood starting from the equilibrium condition in the goods market of the Center. Other things equal, a real depreciation of the Periphery country j's currency shifts demand in the Center away from the goods produced either in the Center or in the rest of the Periphery (that is, in any country i) and toward country j's goods. This is the expenditure-switching e¤ect associated with a monetary expansion in country j, which lowers aggregate demand in the rest of the Periphery. However, as output supply in the Center is unchanged, equilibrium requires a fall in the Center's real interest rate, r^{α}. Ceteris paribus, the fall of r^{α} lowers the real interest rate in all other countries and boosts demand for the Periphery's output. This is the expenditure-changing impact of a monetary expansion in country j: it increases global demand by lowering the "world" interest rate.[14]

Thus, if the elasticity of the aggregate demand with respect to the real exchange rate is large enough, the expenditure-changing e¤ect of a monetary expansion by any one Periphery country prevails over the expenditure-switching e¤ect: its real exchange rate appreciates and the real interest rate falls in the rest of the Periphery. The spillovers associated with a monetary expansion by one country may of course have the opposite sign. As is clear from the expression for the country-speci…c shock (6), it is the parameter $\Re_1$ that determines the sign of the e¤ect of a monetary expansion in one country on employment and price level elsewhere in the system:[15] $\Re_1$ is positive if and only if the expenditure-changing e¤ect prevails.

As well known, in the empirical literature there exists considerable dis-

agreement on the sign and the size of international spillovers.[16] However, in the context of our study, there are compelling reasons to believe that the relevant spillovers among the ERM countries best …t the pattern of a prevailing expenditure-changing e¤ect. Ex-post, there are few doubts that the ERM devaluations in 1992 substantially contributed to the rapid fall of interest rates both in Germany and in the rest of the system (France and the UK represent particularly spectacular cases) between 1992 and 1993. A striking visual representation of this point is provided by Figure 1, that shows the plot of short-term nominal and real interest rates in Germany in the 1990's (the spike in the graph corresponds to September 1992).

Insert Figure 1 here

To the extent that the impact of the "swing" of German interest rates on the economies of the European Periphery is considered as the predominant macroeconomic issue in the unfolding of the ERM events (the consensus view), there is strong evidence in support of our assumption that, on balance, the net e¤ect in the transmission of monetary policies in Europe was positive ($®_1 > 0$). It is worth noticing that this assumption does not rule out the possibility of shifts in demand — from strong- to weak-currency countries' goods — following a devaluation: rather, it de-emphasizes their relevance vis-à-vis the impact of a system-wide fall in interest rates.

4 Non-cooperative equilibrium: the role of domestic credibility

The analysis of the equilibrium begins with the determination of the optimal monetary policy of a representative Periphery country. At any point in time, the problem faced by the monetary authority of country i can be thought of as a nested choice. First, the policy maker will determine whether to maintain or abandon the peg, knowing that reneging on the commitment to peg the currency brings about a reduction of utility by some …xed amount c_i. Second, contingent on the peg having been abandoned, the size of the monetary expansion is chosen; given the positive relation between a country's money supply and its exchange rate, this translates into the determination of the optimal size of the realignment. At the time when such decisions are taken, the monetary authority of the Periphery country i takes into account the following variables: the demand shock in the Center, $²_t$; the stance of monetary policy in the rest of the system, that is $m^¤_t$ and $m_{j;t}$ for all Periphery countries $j \neq i$; and the wage level set in the domestic labor market w_t.

4.1 Characterizing the optimal monetary policy: the shadow devaluation rate

The optimal policy rule for country i combines two different monetary regimes. In one the money stock is consistent with the survival of the peg. In the other one the peg is abandoned and the money supply optimally responds to fundamentals. Consider first the optimal monetary policy conditional on the peg having been abandoned. If the current exchange rate parity is no longer a binding target or constraint, the policy maker will minimize the loss function $\ell_{i,t}$ by choosing a money supply such that

$$\frac{\partial \ell_{i,t}}{\partial m_{i,t}} = \left[n^{FL}_{i,t} - \bar{n}_i + \gamma \alpha_0 \left(q^{FL}_{i,t} - \bar{q}_{i,t} \right) \right] = 0 \qquad (14)$$

where the superscript "FL" refers to "conditional on abandoning the peg".[17] If instead the policy maker decides to defend the current parity, the monetary policy is implicitly determined by expression (1), positing $s_{i,t} = \bar{s}_{i,t}$:

$$n^{FX}_{i,t} - \frac{\bar{s}_{i,t} - w_{i,t} - \lambda_{i,t}}{\alpha_2} = 0 \qquad (15)$$

where the superscript "FX" refer to "conditional on defending the peg".

As regards the choice of exchange rate (and monetary policy) regime, the policy maker will opt for abandoning the peg if and only if the loss under a peg is larger than the loss associated with a devaluation, including the lump-sum welfare cost c_i:

$$\frac{1}{2} \left\{ \left[(n^{FX}_{i,t} - \bar{n}_i)^2 + \gamma (q^{FX}_{i,t} - \bar{q}_{i,t})^2 \right] - \left[(n^{FL}_{i,t} - \bar{n}_i)^2 + \gamma (q^{FL}_{i,t} - \bar{q}_{i,t})^2 \right] \right\} \geq c_i \qquad (16)$$

The above expressions completely characterize the optimal policy.

In what follows, we will show that there is a simple yet insightful way to re-parametrize the optimal switching between the two regimes. Define the shadow devaluation rate (henceforth the SDR) as the difference between the (optimally chosen) value of the exchange rate if the peg were abandoned and the target exchange rate. The SDR will be denoted $\phi s_{i,t}$. By definition, the prevailing exchange rate conditional on the abandonment of the peg will be $s^{FL}_{i,t} = \bar{s}_{i,t} + \phi s_{i,t}$: It is straightforward to show that the shadow devaluation rate is increasing in the predetermined nominal wage, in both the employment and the price targets, as well as in the country-specific shock. It is obviously decreasing in the exchange rate parity that is currently defended.[18]

Note that rearranging the semi-reduced forms (1) and (2), the SDR can also be written as follows

$$\phi s_{i,t} = \alpha_2 \left[n^{FL}_{i,t} - n^{FX}_{i,t} \right] = \frac{\alpha_2}{\alpha_0} \left[q^{FL}_{i,t} - q^{FX}_{i,t} \right] \qquad (17)$$

The interpretation of these relationships brings additional insights on the meaning of $\phi s_{i;t}$: The shadow devaluation rate is proportional to the 'employment gap' ($n^{FL}_{i;t} - n^{FX}_{i;t}$), that is, the loss of employment due to defending the existing parity. It is also proportional to the 'price level gap', that is, the inflation benefit from defending the peg. In either cases, the SDR provides a measure of the welfare opportunity cost of maintaining the exchange rate fixed.

Now, by using (17), we can rewrite the condition for an optimal choice of exchange rate regime (16) exclusively in terms of the shadow depreciation rate:

$$\begin{aligned} s_{i;t} &= \hat{s}_{i;t} && \text{if } |\phi s_{i;t}| < e_i \\ s_{i;t} &= \hat{s}_{i;t} + \phi s_{i;t} && \text{if } |\phi s_{i;t}| \geq e_i \end{aligned} \tag{18}$$

where e_i is a constant.[19] In other words, there exists a threshold value of the shadow devaluation rate that triggers an optimal realignment. The threshold value e_i translates the welfare cost of abandoning the peg into the metric of the SDR.

Expressions (18) draw a simple picture that captures the key features of our model. Consider Figure 2. In this Figure, and throughout this paper, we restrict the support of the shock so as to rule out the possibility of optimal revaluations.[20] On the x-axis we put the support of the shock. On the y-axis we have the shadow and the actual devaluation rates (both conditional on private agents' expectations), as well as the "adjusted" welfare cost of a devaluation e_i. The zero on the y-axis corresponds to the existing parity.

The level of the shock $\lambda_{i;t}$, at which the shadow depreciation rate crosses the cost line, divides the support of the shock in two regions. The policy maker will find it optimal to defend the exchange rate if the shock falls in the region to the left. She will optimally abandon the peg in the region to the right. By construction, the optimal devaluation rate conditional on abandoning the peg coincides with the shadow one. Thus, the actual devaluation rate will be zero in the region to the left of the threshold, equal to the SDR in the region to the right.

Insert Figure 2 here

Analytically and conceptually, the SDR provides a unifying framework for different classes of currency crisis models. In the context of speculative attack models with an exogenously specified monetary rule, Flood and Garber [1984] showed that the private sector will launch a speculative attack, depleting reserves and forcing an abandonment of the fixed parity, as soon as the path of the shadow floating exchange rate crosses the fixed parity from below.

In our setup, the government will choose to abandon the …xed parity, as soon as the shadow ‡oating exchange rate exceeds the …xed rate by a margin su¢cient to cover the sunk devaluation cost.[21]

4.2 Market expectations and wage setting

The second stage of the analysis is devoted to closing the model by considering the determination of nominal wages based on rational expectations of future domestic monetary policies. In the model under consideration, optimizing wage setters will form set their wages according to eqn.(3) above. Since policy makers do not "tie their own hands" and do not commit themselves to the defense of the exchange rate target under all possible contingencies, market participants will forecast the future monetary policy by combining two scenarios, the …rst one assuming a defense of the …xed exchange rate, the second one assuming that the peg is abandoned and that the optimal rate of devaluation is chosen.

We have observed before that the SDR is a linear, increasing function of the demand shock $\grave{A}_{i;t}$. Therefore, for any given probability distribution for $\grave{A}_{i;t}$ (assumed to be common knowledge) there exists a devaluation threshold $\bar{\grave{A}}_{i;t}$, de…ned as the level of the shock such that a devaluation will occur for $\grave{A}_{i;t} > \bar{\grave{A}}_{i;t}$. As Figure 2 illustrates, by de…nition $\grave{A}_{i;t} > \bar{\grave{A}}_{i;t}$ if and only if $¢s > e_i$.

De…ne now the probability of a realignment as

$$¼_{i;t} ´ Prf¢s_{i;t} > e_i g ´ Pr f\grave{A}_{i;t} > \bar{\grave{A}}_{i;t}g: \tag{19}$$

Wage setters' forecasts will be obtained by taking the expectations of $m^{FX}_{i;t}$ and $m^{FL}_{i;t}$ conditional on, respectively, the defense of the peg (FX according to the notation of Section 3) and a devaluation (FL), and combining them according to their respective probabilities:

$$w_{i;t} = E_{t\,i\,1}m_{i;t} = (1\ i\ ¼_{i;t}) \left[E_{t\,i\,1}m^{FX}_{i;t}jFX\right] + ¼_{i;t} \left[E_{t\,i\,1}m^{FL}_{i;t}jFL\right] \tag{20}$$

It bears emphasizing that the wage rate obtained according to the previous expression will be a decreasing function of the devaluation threshold $\bar{\grave{A}}_{i;t}$, so far taken as an exogenous parameter.

To determine endogenously the devaluation threshold under rational expectations, we substitute eqn.(20) into the expression for the SDR. Then, we evaluate the SDR at $\grave{A}_{i;t} = \bar{\grave{A}}_{i;t}$, we equate the SDR to e_i, and solve for $\bar{\grave{A}}_{i;t}$: Algebraic details of the solution are presented in Appendix E.

Without speci…c assumptions on the distribution of the shock to fundamentals $\grave{A}_{i;t}$, very little can be said about the properties of the devaluation

threshold $\grave{A}_{i;t}$. An important point is that, in general, the expression for the SDR evaluated at the devaluation threshold will be non-linear, so that its roots will not be unique. This feature is what raises the possibility of multiple instantaneous equilibria, as we discuss below. We choose to illustrate this point by means of a parametric example, assuming a uniform distribution of the shock.[22]

Insert Figure 3 here

Consider Figure 3, where N_{min} and N_{max} represent the lower and upper boundaries for the country-speci…c shock $\grave{A}_{i;t}$. In the top graph, we plot both the (modi…ed) welfare cost of a devaluation e_i and the SDR evaluated at $\grave{A}_{i;t} = ¹\grave{A}_{i;t}$ against all potential values of $¹\grave{A}_{i;t}$, that is, the support of the shock. There are two crossing points, identifying two possible equilibrium levels for the devaluation threshold. Depending on which instantaneous equilibrium market participants coordinate their expectations on, we have two possible levels of wages and therefore two possible levels of the shadow devaluation rate. This is shown in the graph at the bottom of the Figure, where we include two SDR lines. In each period, once the wage contracts are signed, there can only be one shadow devaluation locus. Before the contracts are signed, however, there could be more than one SDR locus that is a rational expectations equilibrium.

5 Current explanations of the ERM crisis: an analytical review

Most contributions on the ERM crisis are cast in terms of "unilateral peg models" that, as our analysis makes clear, can only characterize partial equilibria of the broader international monetary game. Even granted the partial equilibrium nature of these models, however, it is our view that, in several cases, the models in the literature are developed under unduly restrictive assumptions — especially in the de…nition and interpretation of the shock to fundamentals. It is therefore instructive to re-interpret the most popular explanations of the ERM crisis within our own framework.

The interpretations of the crisis reviewed in this section emphasize the role of domestic credibility, regardless of whether the shock determining the currency crisis originates at home or abroad. Abandoning the peg is ultimately a policy decision, based on a rational assessment of costs and bene…ts of a regime switch. The contingent nature of such a decision underlies the expectation game between the private and the public sector. This game can have multiple instantaneous equilibria, o¤ering the theoretical founda-

tions for the theory that the ERM has succumbed because of destabilizing self-ful…lling prophecies of a crisis. For a given regime of expectations, the stability of the exchange rate depends on the perceived distribution of the shocks as well as on the perceived opportunity costs of a regime switch.

5.1 Shifts in expectations and self-ful…lling equilibria

Consider Figure 3 once again. Suppose that the economy somehow coordinates on a high threshold, low in‡ation, equilibrium (on the right). If a devaluation is perceived as a low probability event, workers settle for a low nominal wage, and employment is, ceteris paribus, high. Only a very adverse realization of the shock (a large value of $À_{i;t}$) will force the monetary authorities to abandon the defense of the exchange rate target in order to maintain the level of employment. Nonetheless, the fact that the system will indeed be safe against devaluation except in the case of very high values of $À_{i;t}$ validates, ex-post, the wage setters' initial conjecture.

Suppose instead that market participants coordinate on the bad, high in‡ation (low $À_{i;t}$) equilibrium, so that unions perceive a high probability of a devaluation. As the nominal wage rate is now relatively high (re‡ecting the higher probability of future depreciation and in‡ation), the monetary authorities will be forced to use a devaluation to restore competitiveness in the international markets in response to even mild shocks. Only if the external conditions turn out to be very favorable, will policy makers prefer to keep the exchange rate …xed.

It is worth emphasizing the self-ful…lling nature of expectations in both equilibria. If nominal wages are set at a high level, the optimal response to external shocks is likely to be a devaluation. At the same time, the monetary expansion associated with a devaluation validates ex-post the in‡ationary expectations of market participants that generated the original high wage. By the same token, if nominal wages happen to be set at a low level, the monetary authorities will be helped by these favorable internal conditions in their commitment to defend the parity. Exchange rate stability (as well as the associated restrictive monetary policy) will con…rm, ex-post, the correctness of wage setters' expectations.

In the post-mortem interpretations of the ERM crisis, unilateral peg models with multiple instantaneous equilibria have provided a popular theoretical foundation for the analysis of self-ful…lling speculative attacks in the foreign exchange markets.[23] According to this approach, an exchange rate crisis due to self-ful…lling speculative behavior consists of a sudden, and completely unanticipated, shift from the good equilibrium to the right of Figure 3 to the bad equilibrium to the left of the same …gure, for unchanged fundamentals.

If a crisis is triggered by such a shift in expectations, the familiar macroeconomic indicators would not give any early indication that a period of exchange rate instability is approaching: up to the dawn of a crisis, forward-looking asset prices in the …nancial markets would re‡ect expectations of a persistence of the good equilibrium.

Indeed, it is apparent that …nancial markets did not anticipate the magnitude of the crisis. The interest di¤erentials between ERM countries and Germany fell on average in 1992; in the summer, there was some worsening of credibility, but only to a very limited extent (Rose and Svensson [1994]). Other indicators of credibility, based on option prices or survey data on exchange rate forecasts, con…rm these results.[24] The popularity of the idea of self-ful…lling speculative attacks is largely due to its ability to explain these large forecast errors without postulating irrationality or …nancial market ine¢ciencies.

A problem with the logical foundations of this view of the crisis is that, while demonstrating the possibility of multiple instantaneous equilibria, the theory is silent on the mechanisms underlying the (sudden shift in the) private sector's coordination on a particular expectation regime. The analysis of a speculative attack as a self-ful…lling prophecy requires a leap from the theoretical identi…cation of the existence of multiple equilibria to the characterization of an economic process (in "real time") that the model per se has nothing to say about: modelling expectations coordinating mechanisms requires further theoretical structures and/or ad-hoc assumptions.

In the literature, expectations coordination mechanisms are commonly modelled in terms of exogenous uncertainty: a random variable is assigned an arbitrary distribution de…ned over possible equilibrium outcomes. The models considered have the property that, provided fundamentals are weak enough, there is, in each period, a positive probability that a "self-ful…lling" speculative attack will occur. Such a black-box approach may be useful in rationalizing the timing of the crisis in a country with a credibility problem (Obstfeld [1994] and Obstfeld and Rogo¤ [1995]): what appears, prima facie, as an arbitrary and irrational switch in currency traders' beliefs, can be interpreted as the shift from one rational expectation equilibrium to another. Nonetheless, if taken too literally — i.e. self-ful…lling prophecies were the cause of the crisis — it can only o¤er a super…cial phenomenological explanation of the 1992/93 currency crisis and of the persistent …nancial instability that followed.

Despite the inherent weakness of this explanation of the crisis, it has been argued that one is virtually bound to conclude that the crisis was indeed triggered by such self-ful…lling speculative attacks, because alternative explanations based on the analysis of fundamentals tend not to perform very

well empirically.[25] Tests have been carried out with reference to standard two-country (or small open economy) unilateral peg models of currency crisis; fundamentals include various measures of employment, activity, relative prices and …scal de…cits. The results show that there is no clear evidence of a deterioration of current macroeconomic indicators preceding the crisis. Also, fundamentals do not seem to di¤er before and after the crisis.[26]

On empirical ground, however, the issue is not at all straightforward, since expectations shifts triggered by self-ful…lling prophecies and expectations shifts re‡ecting fundamental shocks are, to a very large extent, observationally equivalent. In our opinion, a balanced view of the role played by fundamental imbalances in the crisis requires …rst and foremost an appropriate theoretical and analytical framework: the next sections are devoted to a brief discussion of these points.

5.2 Three interpretations of the crisis based on fundamentals

The literature has provided at least three interpretations of the ERM crisis based on economic and political fundamentals. The …rst one stresses the role of the German reuni…cation shock, and of the German …scal-monetary policy mix that accompanied it. The second is focused on the perceived weakening of the political consensus in favor of the European monetary project after the …rst Danish referendum. The third one stresses the role of competitiveness losses implied by a disin‡ation strategy based on a …xed exchange rate.

5.2.1 German uni…cation shock: the role of learning and expectations updating

The basic elements of the …rst story are well-known.[27] The German domestic demand boom, partly fueled by the sustained and largely de…cit-…nanced …scal transfers from the West to the Eastern regions of the country, partly fueled by the conversion of GDR-Marks into D-Marks at the overvalued average rate of 1:8 to 1, put upward pressures on the German real exchange rate. Given the Bundesbank's commitment to contain in‡ationary pressures, a D-Mark real appreciation would require either a nominal devaluation or a de‡ation in the rest of the ERM. The employment and …scal costs of such a de‡ation undermine the stability of the exchange rate.

One of the most common objections to explanations of the crisis based on the German reuni…cation shock concerns timing. Why does the 1990 German reuni…cation shock bring about a crisis in 1992? If such a shock was

so important, shouldn't forward-looking financial markets have anticipated the crisis well before 1992?

In the light of our model, this objection has little ground. Once the model is specified appropriately, the role of current aggregate demand shocks in generating a currency crisis is greatly reduced. Disregard for the time being the international spillovers and the policy game, and focus on the nature of the Center demand shock. The relevant shock to fundamentals ε_t is the innovation to the present discounted value of current and future IS disturbances (broadly interpreted to include the German monetary-fiscal policy mix following unification), λ^*_t in Appendix A. This feature of the model means that considerations about the stability of the distribution of the shocks, their persistence over time, as well as the learning process should be given appropriate weight in the analysis of the crisis. In terms of our reconstruction, two specific points can be made about the behavior of the fundamentals.

First, private agents may have been unable to disentangle the permanent and transitory components of the shock. In this case, it is well known that rational forecasts will be characterized by a typical adaptive pattern and "learning" behavior. As the magnitude and duration of the West-to-East fiscal transfers associated with German unification was only revealed gradually, the full implications of the shock for the stability of the exchange rate could only emerge over time.

Second, German reunification, and the German macroeconomic policy response to it, was an unprecedented economic and political event. To the extent that the nature of the shock made it difficult to evaluate the parameters of the structural form, estimates of its magnitude and persistence were likely to be subject to drastic revisions over time.

To clarify this point, assume that the relative demand disturbance is generated by a simple first-order autoregressive process

$$\lambda^*_t - \lambda = \rho\left(\lambda^*_{t-1} - \lambda\right) + \eta_t; \quad 0 < \rho < 1 \tag{21}$$

where the innovation η_t is i.i.d. with zero mean. The higher the coefficient of serial correlation (ρ), the more persistent the relative IS disturbance. It follows that the (absolute value of the) exogenous shock to fundamentals in eqn.(6) will be increasing in ρ:

$$\varepsilon_t = \frac{\gamma}{\nu(1 - 2\beta)} \frac{\lambda^*_t - \lambda}{1 - \gamma\rho} \tag{22}$$

A sudden revision of the parameter ρ implies a jump in the shock to fundamentals ε_t for any given realization of λ^*_t. This process of revision occurs over time and is not necessarily smooth.

The uncompromising attitude of the Bundesbank — insofar as interest rate policy was concerned —was fully revealed only at the dawn of the crisis. It is worth recalling that even at the Bath meeting on September 5-6 1992, the possibility of an interest rate cut was considered a feasible policy option by ERM policy-makers, including the British Chancellor of the Exchequer.[28] The perceived intransigence of the German authorities might have translated into a reassessment of the persistence of the high interest rate regime, indexed by an upward jump in ½ in our setup. As a consequence, in the framework of Figure 2, $²_t$ and the entire structure of country-speci…c shocks $À_{i;t}$ could have suddenly jumped from the left to the right of the devaluation threshold $¼À_{i;t}$, triggering a currency crisis.

While we believe that the international policy game has played a far more important role in the crisis than learning and revision of expectations, (leading us to add the rules of the international policy game to the list of fundamentals in Section 6 below), one cannot dismiss the importance of these other considerations. Our analysis suggests caution in relying too much on empirical evidence on "contemporaneous shocks" to fundamentals, those related to the German uni…cation shock as well as others. The absence of any obvious contemporaneous change in observable macroeconomic variables may not carry much weight in one's interpretation of the crisis, once the intertemporal nature of shocks to fundamentals is taken into account appropriately.

5.2.2 The perceived change in policy-makers' commitment to exchange rate stability

The focus of the second interpretation of the crisis as the result of developments in fundamentals, is on the policy makers' commitment to exchange rate stability. At the beginning of the 1990's, the perceived political bene…ts from participating in the ERM were high. Price stability being a national priority, governments tended to base the credibility of their anti-in‡ationary policies on their ability to maintain a stable exchange rate vis-à-vis the D-mark. The …rst Danish referendum, and later public opinion polls in France, revealed that the popular consensus over Maastricht was much weaker than previously believed. The social costs of de‡ationary policies, exacerbated by the regime of high interest rates following German reuni…cation, suddenly became less bearable. The temptation to correct domestic imbalances through a devaluation grew stronger. An interpretation of the crisis in terms of a political shock helps explain its timing and persistence, insofar as the weakening of popular support for Maastricht spreads to the entire EMS.

In our theoretical framework, the e¤ect of a downward revision in the perceived political cost of a devaluation can be modeled as a decrease in the

welfare cost c_i (and θ_i). Focusing on a good, low inflation, rational expectation equilibrium, such as the one to the right of Figure 4, it is apparent that a downward shift in θ_i increases the probability of a crisis, lowering the threshold $\lambda_{i,t}$ and increasing the equilibrium nominal wages. For the new level of nominal wages, the SDR line in the graph shifts to the left.

Insert Figure 4 here

In principle, more could be said in this respect within a theoretical framework where political costs are made explicit in terms of acceptable primitives. The literature provides a few examples of such theoretical exercises. Froot and Rogoff [1991] point out the destabilizing end-game effects of the Maastricht time-table for EMU, insofar as deadlines raise the temptation to resort to a final realignment before locking in the exchange rate irrevocably at a fixed Euro conversion rate. Currie [1992], among others, carries out welfare analysis based on the social loss function (8), comparing EMU to alternative exchange rate arrangements. As the sign of the net gains from EMU compared to an adjustable peg is qualitatively ambiguous, quantitative welfare analysis is required to shed light on the reasons for the expressions of political disagreement on the Maastricht project. However, any interpretation of the ERM events within this framework is contingent on (arbitrary) assumptions concerning the expected monetary stance of the European central bank following EMU. As shown in Alesina and Grilli [1993], the results of such a quantitative welfare analysis depend crucially on whether or not, or to what extent, national policy preferences will be reflected in the behavior of the European Central Bank.

5.2.3 Inherent weakness of disinflation policies based on an external nominal anchor

The third "fundamental" explanation points to an inherent weakness of any price stabilization policy based on pegging the exchange rate. If either inflation has inertia or the new exchange rate regime is not perfectly credible, the policy initially results in an appreciation of the real exchange rate. Worsening competitiveness affects the trade balance, production and employment. A successful implementation of the policy thus requires a country to push its domestic rate of inflation below that of the Center country in order to offset the initial real appreciation. Since the costs of the required deflation are generally high, the commitment to maintain the exchange rate parity may not be credible.

Such a scheme applies reasonably well to the Italian and the English cases. It does not explain, however, why speculative attacks hit the cur-

rency of countries, such as France, where there are no unambiguous signs of a deteriorating external competitiveness (conventionally measured by real exchange rates based on CPI or unit labor costs).[29]

A model with one-period wage contracts can only o¤er a stylized account of these e¤ects based on the consequences of imperfect credibility on the output and competitiveness of a country. Without an in‡ationary bias in the Periphery, the equilibrium real exchange rate in our would not change in response to the Center shock. As long as the commitment to the …xed parity is not perfectly credible, a disin‡ation policy based on an external nominal anchor causes the competitiveness of the Periphery countries vis-a-vis the Center to deteriorate. This in‡ationary bias and the associated real exchange rate overvaluation persists as long as the imperfect credibility persists.

It is also possible to generalize the theoretical framework, by including multi-period wage contracts – a rather demanding approach on technical grounds – or by making the costs of disin‡ation policies lasting for more than one period. Drazen and Masson [1994], for instance, adopt a theoretical framework that incorporates hysteresis in unemployment. As a result, a tough stance in defense of the exchange rate parity increases the "natural" rate of unemployment over time. Obstfeld [1994] discusses a model where the domestic policy game is not de…ned in terms of the trade-o¤ between in‡ation and unemployment, but in terms of the trade-o¤ between the distortions of in‡ation and the distortions due to a high level of non-lump sum taxation, faced by a government with a high public debt. In both examples, the presence of a state variable – the 'memory' of past unemployment rates in one case and the level of public debt in the other case – captures the cumulative cost of defending the peg. In both cases, a currency crisis can occur despite stable or even improving current fundamentals: it is in fact the cumulative e¤ect of the fundamental 'stock', not the marginal e¤ect of its '‡ow', that matters in determining the timing of a devaluation.

6 Non-cooperative equilibrium: the systemic dimension

6.1 The missing element: modelling the international policy game

While private-public sectors interactions at the domestic level are certainly an important part of the process that brought down the ERM, explanations

of the 92-93 crisis that focus exclusively on the national dimension are bound to miss a key element. As we have seen, the domestic shadow devaluation rate completely characterizes the monetary policy of a country. Nonetheless, for any given structure of spillovers, it is not possible to determine an individual country's SDR without knowing the policy stance of the other countries in the system. To this issue we turn next.

Our approach stresses an explanation of the crisis in terms of fundamentals, but augments the traditional list of fundamentals with the rules of the international monetary policy game, that is the cooperative or non-cooperative design of monetary and exchange rate policy in the Periphery. While our approach does not rule out the possibility of multiple instantaneous equilibria for given fundamentals, it goes through even if the domestic equilibrium is unique.

In our discussion, we will assume that the private sectors of each and every country coordinate on the same equilibrium. Throughout the analysis, we will make the simplifying assumptions that all policy makers in the Periphery have the same employment target and face the same welfare cost of a devaluation:

$$\hat{n}_i = \hat{n} \text{ and } c_i = c \qquad \text{for all countries } i: \tag{23}$$

We also assume that the private sectors coordinate their expectations on the same (multi-country) equilibrium, that is

$$w_{i;t} \; ¡ \; \$_i = w_{j;t} \; ¡ \; \$_j \qquad \text{for all countries } i; j: \tag{24}$$

E¤ectively, therefore, all countries in the Periphery are ex-ante identical.

To avoid misleading interpretations, it is worth emphasizing that the assumptions of symmetry (23) and (24) are only made in order to highlight the speci…c role of international policy coordination in the logic of an exchange rate regime crisis, while abstracting from cross-country di¤erences in economic structure, inherited economic conditions, domestic credibility and subjective expectations. Asymmetries between European countries in the early 1990s were by no means negligible, and there is no doubt that such di¤erences should be taken into account in a complete assessment of the ERM crisis. Nevertheless, the twelve months spanned by September 92 and August 93 witnessed a wave of crises within the ERM which appear to be unrelated to visible divergences in macroeconomic policy stance and economic performance among European economies.

To the extent that the 92-93 events in Europe represent the breakdown of a system, rather than the crisis of the unilateral exchange rate policies undertaken by a collection of isolated countries, intra-Periphery asymmetries

do not help understand the nature of the ERM puzzle. Thus, the (admittedly unrealistic) assumption of symmetry in our exercise allows us to focus on the crucial issues at stake, while de-emphasizing other factors contributing to the crisis.

As wages are taken as given parameters, and the determination of market expectations is left backstage in what follows, there is no need to emphasize further the time dimension of our model. Therefore, for notational convenience we will drop time subscripts throughout the rest of the paper.

6.2 Monetary strategies in the Center and the Periphery

In the absence of coordination, each country takes monetary 'actions' in other countries as given, and determines its optimal 'reaction'. Consider the Center first. As the Center optimally pursues a Friedman-style monetary rule, its policy strategy completely insulates employment from domestic and external disturbances. The Center "reaction function" is therefore

$$n^* = 0 \tag{25}$$

In the Periphery, each country determines its optimal monetary strategy according to the analysis of Section 4.1. Due to the presence of lump-sum realignment costs, the reaction function for the representative Periphery country i is discontinuous: by using (14), (15) and the definition of the shock υ_i, we can in fact characterize the Periphery reaction function as follows:

$$\begin{aligned} n_i &= \frac{1}{\alpha_2}\left(\bar{s}_i + \Delta s_i - w_i - \varepsilon\right) + \frac{\alpha_1}{\alpha_2}\sum_{j \neq i} n_j \\ \Delta s_i &= \begin{cases} 0 & \text{if } \Delta \tilde{s}_i < \bar{c} \\ \Delta \tilde{s}_i & \text{if } \Delta \tilde{s}_i \geq \bar{c} \end{cases} \end{aligned} \tag{26}$$

This expression makes it clear that the sign and the magnitude of the spillover effects (the parameter α_1) are central to our interpretation of the Periphery reaction functions and the Nash equilibrium they support. The reaction function (26) shows that, if α_1 is positive, the money stocks of any pair of countries, j and i, are strategic complements:[30] for a positive α_1; the best response to country j's monetary expansion is a monetary expansion in country i as well.

An important implication of a dominant expenditure-changing effect ($\alpha_1 > 0$) is that a monetary expansion in one country tends to enhance the stability of the peg in all other Periphery countries, because it lowers their shadow devaluation rate (and the welfare gain from a devaluation) for any level of the exogenous shock.[31]

6.3 The optimal number and size of exchange rate realignments

Once monetary policies are determined on the basis of the reaction functions (26), it is possible to characterize the international dimension of the non-cooperative (Nash) equilibrium as follows. The support of the shock ε is split into three segments, defined in terms of two thresholds: a lower threshold denoted by $\underline{\varepsilon}^d$ and an upper threshold denoted by $\overline{\varepsilon}^d$. In equilibrium, all Periphery countries defend the peg when the shock ε is below the lower threshold $\underline{\varepsilon}^d$; all Periphery countries jointly devalue their currencies by the same percentage when the shock is larger than the upper threshold $\overline{\varepsilon}^d$; some Periphery countries (N^{FL} of them) devalue their currencies while some ($N - N^{FL}$) maintain the peg when the shock falls between the two thresholds ($\underline{\varepsilon}^d$ and $\overline{\varepsilon}^d$). In this equilibrium, no Periphery country finds it optimal to devalue against the Center when some other Periphery country revalues instead.

While leaving the analytical derivation of these results to Appendix F, we summarize and visualize the properties of the Nash equilibrium in Figure 5. The graph at the top plots the fraction of countries abandoning the peg (N^{FL}/N) against the support of the shock ε. The second graph plots the shadow devaluation rate – which, for each country that abandons the peg, is also that country's actual depreciation rate – against the support of the shock ε. The graph at the bottom presents the information contained in the first two graphs in a different way, by plotting the average depreciation rate of the Periphery as a whole vis-à-vis the Center.

Insert Figure 5 here

To understand the economic intuition underlying these graphs, compare Figure 5 with Figure 2, where the shadow devaluation rate is plotted against the country-specific shock λ_i. In Figure 2, the higher the country-specific shock, the higher the devaluation rate if the Periphery country finds it optimal to abandon the peg. At the point $\lambda_i = \bar{\lambda}_i$ the country is indifferent between devaluing and not devaluing by the percentage δs_i: in other words, at the threshold $\bar{\lambda}_i$, the welfare benefits of a devaluation in terms of higher employment are exactly offset by the political loss of anti-inflationary reputation.

Now, recall that the country-specific shock is a combination of the global shock ε and the monetary stance in the rest of the system. Thus, λ_i can be equal to $\bar{\lambda}_i$ when the global shock is relatively low and no Periphery country expands its money supply. Equally, λ_i can be equal to $\bar{\lambda}_i$ when the global shock is sufficiently large and many Periphery countries follow

expansionary policies and devalue. We conclude that there is a continuum of combinations of θ, the fundamental shock, and N^{FL}, the number of countries that choose to devalue, for which a Periphery country remains indifferent between maintaining the peg and devaluing at the the constant rate $\dot{s}_i = \varepsilon$. Thus, when we plot the shadow devaluation rate $\dot{s}_i$ against the support of the shock θ, as in Figure 5, the point corresponding to the value of $\lambda_i = \bar{\lambda}_i$ in Figure 2 stretches over some range of θ; the edges of this range in Figure 5 are $\underline{\theta}^d$ and $\bar{\theta}^d$.

6.4 Asymmetric exchange rate policies, symmetric welfare levels

Each country, taking as given the behavior of all other countries, will independently determine whether it is preferable to peg or float according to the rule given in eqn. (18), that is, by comparing the country-specific shadow devaluation rate with the devaluation threshold. The model determines the number of countries that will devalue in equilibrium. Which countries will actually abandon the peg is not determined. Only when the shock θ is either extremely high or extremely low, will the exchange rate behavior be identical across ex-ante symmetric countries (either they will all peg, or they will all devalue by the same amount). It is important to stress that, in the Nash equilibrium we have constructed, Periphery countries that start off identical also share the same level of welfare ex post for any realization of the shock, even when their exchange rate policies differ.

This latter point deserves special attention. In order to stress the role of the international factors in influencing the behavior of the national policy authorities, we have abstracted from structural differences at the national level by assuming perfectly symmetrical countries. Yet, as stated before, for some intermediate range of the shock, there will be a number of Periphery countries which find it optimal to abandon the peg while the other countries optimally maintain the defense of their exchange rate parities. In other words, Periphery countries facing the same global shock will act in a highly asymmetric way.

Ex-ante, the policy-makers in the Periphery countries are all equally credible in their commitment to keep the exchange rate fixed; the fundamentals of each economy are exactly the same, except for differences induced by the behavior of other countries. However, because of the international spillovers from domestic policy making, the macroeconomic outlook of ex-ante identical countries may vary considerably ex-post. Some economies will have higher inflation, lower unemployment and a depreciated currency, while some other

economies will keep in‡ation down at the cost of relative higher unemployment without devaluing their currencies.

The sustainability of the exchange rate regime in the second group is helped by the behavior of the …rst group. This is because, under reasonable assumptions on the sign of international policy spillovers, the monetary expansion induced by a devaluation in country j (say, UK) lowers the real interest rate in the Center country and everywhere in the system, reducing …nancial tensions in country i (say, France) that does not devalue. At the same time, the devaluation of the …rst group of countries reduces CPI in‡ation in the second group.

The presence of intra-Periphery spillovers creates strategic interactions among policy makers: heuristically, the devaluation of country j's currency will a¤ect the decision of country i through a shift to the right of this country's SDR for any level of the shock to fundamentals ^{2}. Should the Periphery countries try to internalize these e¤ect in their policy making? What are the implications of policy coordination for the stability of the exchange rate system? This question is addressed by the next section.

7 Cooperative equilibrium and national horizontal equity

7.1 Welfare implications of the international monetary spillovers

Before delving into the analysis of the cooperative equilibrium, it is important to check whether the kind of international policy spillovers we have been focusing on are positive or negative from the point of view of welfare in the other countries in the system. We have shown that, under the maintained assumption that the expenditure-changing e¤ects of a monetary expansion prevail over its expenditure-switching e¤ects in the rest of the Periphery ($®_1 > 0$), monetary instruments are strategic complements in the policy game. We can now show that, in the presence of shocks to aggregate demand in the Center, a monetary expansion in country j has a positive external e¤ect on welfare of country i.

To see this, it is su¢cient to consider the case of a shock to aggregate demand in the Center that is high enough to trigger a common devaluation in the Periphery when all countries play Nash. Focus on country i. In this country, holding domestic money supply (and employment) constant, higher values of the shock ^{2} translate, other things equal, into a higher depreciation

rate and therefore into a higher domestic CPI level. Now, under our hypotheses about the international transmission of monetary policy, a devaluation by any other Periphery country will induce an appreciation of country i's currency vis-à-vis the Center, partly o¤setting the in‡ationary consequences of the shock to aggregate demand in the Center. As the international spillovers of a monetary expansion in another Periphery country reduce country i^0s CPI toward its current target value, its optimal monetary policy (conditional on abandoning the peg) becomes more expansionary, bringing employment closer to its target level and increasing domestic welfare.[32]

We may expect that, in the presence of welfare incentives to coordinate national monetary policies and internalize reciprocal spillovers, a system of exchange rates based on an international agreement like the ERM could provide the appropriate institutional framework to do so. Coordination, however, may not be a feasible option: not only because the cooperative equilibrium requires an e¤ective enforcement mechanism (to prevent individually rational unilateral deviations from the agreement) that may not be available to the countries in the system in all circumstances, but also because there may be lack of consensus and agreement on how the costs and bene…ts from coordinated policies should be distributed among the individual countries.

7.2 Politically feasible cooperation

What determines the feasibility of international monetary cooperation? We build a scenario making three descriptively realistic (in the context of the ERM) assumptions about the nature of the game played by the Periphery countries and the Center. First, the Center never coordinates its monetary policy with the Periphery, while the Periphery countries can cooperate among themselves. Second, intra-Periphery cooperation is subject to a national horizontal equity constraint. This constraint requires all cooperating countries (which are identical ex-ante) to be equally well o¤ ex-post. Third, we rule out side-payments among the Periphery countries. In this section we brie‡y discuss the rationale underlying these three assumptions.

First, in making the Center's monetary policy always independent of policies in the Periphery, regardless of whether these are coordinated or not, we abstract from issues regarding cooperation between the Center and the Periphery. Our maintained hypothesis is that cooperation is perceived in the Center as an unacceptable compromise on internal objectives. Some authors have even pointed out that a Center-Periphery coordination may not be in the interest of the Periphery either, to the extent that international compromises undermines the anti-in‡ationary credibility of the conservative central bank in the Center country (Alesina and Grilli [1993]).

Second, the case we focus on has all Periphery countries cooperating to minimize the sum of the individual loss functions, internalizing the monetary externalities: Even though all Periphery countries are structurally identical, this need not automatically imply that in a cooperative equilibrium they would either achieve equal welfare or adopt the same policies. Obviously, the existence of the …xed (sunk) per-country cost of abandoning the parity implies that, for small shocks ²; it might be e¢cient — as regards the sum of the national welfare levels— to have but a few countries devalue, even if this would make the devaluing countries worse o¤ than the remaining countries that stick to their …xed parities.

The question is then whether schemes of cooperation with the property that ex-ante identical countries are not guaranteed to be equally well o¤ ex post can be said to be characteristic of actual policy making in Europe. Although technically possible and economically e¢cient, such schemes would hardly be considered politically acceptable. First, there could be considerable disagreement about the nature and the magnitude of the common shock as well as about the severity of the domestic credibility problem. Second, because of uncertainty regarding the shock and di¢culty in monitoring individual policy makers' behavior, complex cooperation schemes may create incentives to misbehave that substantially reduce the gains from cooperation.

For these reasons, we impose in what follows as a "primitive" a national horizontal equity constraint in the joint maximization problem de…ning the cooperative agreement.[33] This constraint states that, if the Periphery countries are symmetric before the shock is observed, no Periphery nation would agree on implementing a cooperative action that would, ex-post, make it worse o¤ than any other Periphery nation.[34] In other words, no discrepancy in welfare levels among symmetric Periphery countries is permitted under any circumstances.[35]

Third, a restriction of identical ex-post utility levels need not translate into a restriction of symmetric use of the policy instruments. In principle, a system of redistributive international transfers could remove asymmetries in welfare levels generated, on impact, by nationally di¤erentiated policy measures within a cooperative framework.[36] Contingent transfers could therefore be used to compensate the declining competitiveness of the countries that do not devalue. It is worth stressing that such a view neglects the costs associated with the loss of reputation and anti-in‡ationary credibility accompanying a realignment. It may well be that, under a national horizontal equity constraint, transfers would paradoxically run in the opposite direction, from countries that keep the exchange rate …xed (thus gaining "more" in terms of disin‡ation) to those that give up the exchange rate parity.

We believe that ruling out these kinds of transfers or side-payments as a

maintained hypothesis captures a realistic feature of the actual working of the ERM. Of course there are many intra-EU transfers, with a wide variety of motivations and goals, many of which are designed to meet speci…c distributional or re-structuring objectives. However, to our knowledge, there is no transfer ‡ow contingent on the implementation of coordinated exchange rate policy, or of any other aspect of macroeconomic policy.[37]

In our symmetric context, when all intra-Periphery externalities are taken into account and side-payments are ruled out, the behavior of each single Periphery country must be equal to the average behavior of the Periphery as a whole: if a realignment occurs, all Periphery countries realign simultaneously and by the same amount. We provide an admittedly extreme but instructive scenario in which distributional con‡icts in designing joint exchange rate policies may actually inhibit desirable policy initiatives.

Insofar as the realism of our framework is concerned, it is worth recalling that generalized devaluations represented an institutional reality in the history of the ERM since its very early stages. Six out of eleven realignments between 1979 and 1987 involved all ERM currencies (excluding the Dutch guilder, which was realigned only in two cases). The other realignments, which involved only one or two currencies, were typically triggered by speci…c national contingencies rather than representing the collective response to global shocks, such as a sharp fall of the US dollar.[38]

Summarizing, we restrict cooperative behavior in the Periphery to be symmetric. In our framework, countries can only agree on symmetric devaluation, that is, devaluation at a common rate, or no devaluation. As we will show, under some circumstances — that is, when the national horizontal equity becomes a binding constraint — it may be collectively rational to give up cooperation. If there is no feasible way to solve the distributional con‡icts involved in coordination, then uncoordinated Nash behavior may be welfare-improving for both individual countries and the ERM as a whole, as long as it leads to a higher overall degree of monetary expansion in response to the Center shock.

7.3 Optimal policies and equilibrium under symmetric cooperation

If all Periphery countries coordinate and act symmetrically, they e¤ectively behave as if they where a single currency area vis-à-vis the Center, by internalizing all the cross-country e¤ects on employment and in‡ation of their national monetary policies. Consider …rst the optimal monetary policy conditional on a coordinated symmetric abandonment of the peg. Given that

the common objective function is the equally weighted sum of domestic objective functions, the optimal money supply in the representative Periphery country i satis…es

$$n_i^{CS} - \bar{n} + \tfrac{1}{4}(\alpha + \bar{\alpha})(q_i^{CS} - \bar{q}_i) = 0 \tag{27}$$

where the superscript CS refers to coordinated symmetric behavior by the Periphery countries.

Policy makers will resort to a coordinated symmetric revaluation or devaluation of the domestic currencies if and only if

$$\sum_{i=1}^{N} \frac{1}{2}\left[(n_i^{FX} - \bar{n})^2 + \tfrac{1}{4}(q_i^{FX} - \bar{q}_i)^2 - (n_i^{CS} - \bar{n})^2 + \tfrac{1}{4}(q_i^{CS} - \bar{q}_i)^2\right] \geq Nc \tag{28}$$

Following our analytical scheme introduced in Section 4.1— algebraic details are presented in Appendix G — this policy rule can be written in terms of the SDR:

$$\phi s_i^{CS} \geq e^{CS} \tag{29}$$

where e^{CS} is a constant.[39] As in the case where individual countries play Nash, the optimal choice of exchange rate regime requires the comparison of the SDR with the cost of abandoning the peg expressed in the appropriate metric.

The SDR under policy-coordination is of course di¤erent from the SDR under Nash behavior, as it corresponds to a di¤erent optimal monetary policy. Expressing the SDR as a function of the shock to fundamentals, it is straightforward to show that there exists a threshold value of the shock θ^{CS} such that the Periphery will jointly devalue for $\varepsilon \geq \theta^{CS}$, and jointly maintain the peg for $\varepsilon < \theta^{CS}$.

8 Currency crises as systemic failures

8.1 Cooperative and Nash equilibria compared

We compare the Nash and the cooperative equilibria in Figures 6a and 6b. Each Figure includes three graphs, plotting the shadow depreciation rate, the number of countries devaluing and the average devaluation rate for both equilibria against the support of the shock. The two …gures are drawn for di¤erent values of the parameters: in particular, the in‡ationary bias in the Periphery of the system is "worse" in Figure 6a compared to 6b. In each graph, the solid line refers to the non-cooperative equilibrium, the broken

line to the cooperative equilibrium.

Insert Figure 6a and 6b here

There are three results worth emphasizing. First, the level of the shock that triggers a generalized devaluation in the Periphery of the system is smaller under cooperation than under Nash — compare the position of the relevant threshold values $\theta_2^{CS} < \theta_2^{d}$ in both Figures 6a and 6b. This result stems from the assumption of positive external effects of domestic monetary policy. Intuitively, as Canzoneri and Henderson [1991] put it, "when policy makers impose positive externalities on one another, cooperation calls for doing more, rather than less". Thus, for any distribution of the shock, a simultaneous realignment by all countries is 'more likely' under symmetric cooperative behavior than under Nash.

However, symmetric coordination need not imply more frequent realignments tout-court, as, under Nash, uncoordinated devaluations by a subset of countries are possible also for $\varepsilon \cdot \theta_2^{d}$. In Figure 6b, for instance, when ε is between $\underline{\varepsilon}^{d}$ and θ_2^{CS}; some countries will devalue in a Nash equilibrium, while all Periphery countries will maintain the peg under a cooperative agreement.[40]

Our second point refers to the magnitude of realignments rather than on their likelihood or "timing". Provided that a coordinated realignment occurs, the average devaluation by the Periphery countries as a group will be larger in a coordinated equilibrium than under Nash, even when the individual country's optimal depreciation rate (conditional on abandoning the peg) is higher in a Nash equilibrium.

Such a result is shown by the graphs at the bottom of Figure 6a and 6b, where, to the right of the threshold ε^{CS}, the broken line (Coordination) is always above the solid line (Nash). The nature of the external effect of a Periphery country's monetary policy on the other Periphery countries' welfare provides the rationale for this result. For shocks large enough to make all countries devalue in both equilibria, the average money supply in the Periphery will be larger in a symmetric cooperative equilibrium than in a Nash equilibrium. The (common) devaluation rate will correspondingly be higher in the symmetric cooperative equilibrium. A fortiori, for smaller shocks (yet large enough to make all countries devalue in a coordinated symmetric equilibrium), a Nash equilibrium results in a suboptimally low average monetary expansion in the Periphery, implying an average depreciation lower than in the case of symmetric coordination.

Nevertheless, it is possible that an individual country devalues more in a Nash equilibrium than in a coordinated symmetric equilibrium. Such a possibility is illustrated by the plots of individual devaluation rates in the middle

of both Figures 6a and 6b. In these plots, there is a range of realizations of the shock for which the solid line is above the broken line. In this case, the subset of countries that devalue in a Nash equilibrium do so at an individual rate higher than the common devaluation rate in a symmetric coordinated equilibrium. Note that, as shown by Figure 6a, this is a possibility also when Periphery countries resort to coordinated devaluations much "before" any country would devalue in a Nash allocation ($\underline{z}^d > z^{CS}$).

The explanation of this result has to be found in the differential impact of coordinated and non coordinated devaluations on the real interest rate in the system as a whole. An uncoordinated devaluation by a few countries has a limited impact on the real interest rate in the system. Thus, output stabilization by the countries that opt for a float requires a relative large jump in their exchange rates. A coordinated devaluation by many countries, instead, brings down the system-wide real interest rate substantially. The benefit from a large individual country exchange rate depreciation for output stabilization purposes is much lower, compared to its costs in terms of inflation.

Our third and last point refers to an important effect of the national horizontal equity constraint. When this constraint is binding, there may exist a range of realizations of the shock for which no country devalues in a coordinated symmetric equilibrium, while some countries devalue in a Nash equilibrium. This is illustrated by Figure 6b, where, for values of the shock between $\underline{z}^d$ and z^{CS}, no symmetric devaluation is possible, while some Periphery countries would find it optimal to devalue when playing Nash. In such a range, monetary policy in the system as a whole is less expansionary in a symmetric coordinated equilibrium than in a Nash equilibrium.

The implications of this result deserve special attention, as they stress the possibility that, for given wages, ex post welfare could be higher in a Nash equilibrium than in a coordinated symmetric equilibrium. This will be the case for values of z that are not large enough to trigger a coordinated symmetric devaluation, but large enough to induce an uncoordinated devaluation by some countries in a Nash equilibrium. For such values of the shock, no-cooperation dominates symmetric (constrained) cooperation, from the point of view of the Periphery countries as a group and indeed from the point of view of the system as a whole. This is an important result for our interpretation of the ERM crisis. We will return on this point shortly.

8.2 Policy tensions, market responses, and exchange rate crises

Is there a speci…c role for policy coordination in the crisis of an exchange rate system? An exchange rate arrangement is primarily a mechanism for policy coordination. If the relations between Center and Periphery are assumed to be frozen in non-cooperative behavior, the only coordination options available are those open to the Periphery countries among themselves. To the extent that cooperative behavior prevails in the Periphery of the system (and Periphery countries are ex-ante perceived as su¢ciently similar to each other), the outcome can be described by using the results from our analysis.

Intuitively, in response to a demand shock in the Center, the Periphery will tend not to implement a joint (symmetric cooperative) devaluation, unless the recessionary costs of defending the exchange rate are high enough to o¤set the collective political cost of reneging on the commitment to peg. Conditional on abandoning the peg, the common devaluation rate will be set in a way that fully internalizes all intra-Periphery international spillovers. As the real exchange rate of the Periphery as a whole falls markedly, there is only a limited need to use the exchange rate for stabilization purposes: the common devaluation rate will be small in equilibrium.

A crisis of the exchange rate system is primarily a crisis of the cooperation agreement that de…nes and sustains it. In our theoretical framework, there are at least two ways in which a crisis may emerge. First, to the extent that the coordination scheme lacks an e¤ective enforcement mechanism, individual countries always have an incentive to renege on the agreement and play according to their individual reaction functions. Although the hypothesis of an exchange rate crisis stemming from individually deviant behavior raises an issue of logical consistency — why did the deviant countries accept to be part of the system in the …rst place? —, it is not unrealistic.[41] Consider a realization of the shock slightly larger than $\underline{z}^d$ in Figure 6a. While coordination requires a generalized devaluation, national policy makers may be tempted to "save" their currency. After all, as Figure 6a suggests, in a Nash equilibrium just to the right of $\underline{z}^d$; it may take the devaluation of just one currency to absorb the shock and save the rest of the Periphery from the embarrassment of reneging on the announced exchange rate targets.

If market participants' beliefs are based on the assumption of symmetric cooperative behavior, they will expect, for a shock in the range under consideration, to observe a sizable appreciation of the Center's real exchange rate, to be achieved through cooperative small uniform devaluations of all currencies in the Periphery. In such a situation, a large devaluation by one country provides a strong signal to market participants that national policy

makers are no longer acting cooperatively.

If the Periphery as a whole reverts to undiluted Nash, some countries will maintain their exchange rate parity vis-à-vis the Center. For the others, the equilibrium devaluation rate needs to be large. Since, on average, the monetary stance of the system is not as expansionary as under coordination, real interest rates do not fall as much: devaluing countries will use their exchange rate instrument to target a sustained increase in the level of aggregate demand. Ultimately, large-scale currency crises in a number of countries will be required to modify appreciably the effective terms of trade of the Center. Note that in this first interpretation of a currency crisis $\underline{z}^d$ falls to the right of z^{CS}: therefore, the national horizontal equity constraint is not binding, nor it plays any role in the story.

In our second interpretation of the emergence of a crisis, illustrated in Figure 6b, national horizontal equity is instead an important issue. Consider a realization of the shock in the range $(\underline{z}^d, z^{CS})$: a shock which is sizable but not large enough to justify a collective devaluation puts the system under considerable stress. If a cooperative defense of the peg prevails, the Periphery countries perceive that the individual gains from a unilateral devaluation are high.

Implementing a coordinated but selective (that is, non-universal) devaluation is a problem when there are no instruments to distribute its costs and benefits evenly across nations. For realizations of the shock in the range $(\underline{z}^d, z^{CS})$, the loss in welfare from constrained cooperative behavior is partly avoided in a Nash equilibrium. A Nash equilibrium would accomplish what symmetric coordination cannot: some subset of countries would devalue, making the monetary stance in the system more expansionary (although not by enough to maximize the sum of the national welfare functions).

If policy makers realize that the system is in such a state, it could be collectively rational to revert to Nash, and thus to implement uncoordinated large devaluations. Even if, in the eye of an observer, these devaluations may look like a disorderly response by domestic policy makers to market pressures, they would nonetheless be consistent with (constrained) welfare maximization both at the level of the individual Periphery country and from the point of view of the Periphery as a collective. Yet again, a realignment involving only one country would signal to the private markets that the exchange rate mechanism as a coordination device has ground to a halt.

What is the role of markets in a crisis of the exchange rate system? The answer to this question is complex, because markets play both an active and a passive role. As regards their active role, in our theoretical framework, private sector expectations are reflected in the level of the predetermined nominal variables. Higher nominal wages, ceteris paribus, reduce the stabil-

ity (and viability) of a peg: all threshold values for the shock determining both coordinated or uncoordinated optimal switches between exchange rate regimes are functions of the predetermined nominal variables. On the other hand, once private expectations are formed, exchange rate policies are the outcome of rational decision making by the national authorities, who assess the costs and bene…ts of defending the peg, given the current realization of the shock to the fundamental. In this sense, the behavior of the …nancial markets may be seen as a passive re‡ection of policy makers' choices, and a currency crisis would be nothing but the expression, in the …nancial markets, of the tensions that lead to the breaking up of the international agreement on policy coordination.

Can a system of …xed exchange rates survive a crisis that puts into question its viability as a policy coordinating mechanism? The answer to this question depends on two considerations. First, in the light of the crisis, private agents may modify their priors about the likelihood of future cooperative behavior in the policy game. The levels of wages and domestic interest rates vary with the market's perception of the nature of the ongoing game among policy makers. Therefore, the post-crisis …xed exchange rate system may be intrinsically more or less fragile, depending on the perceived changes in the nature of the game.

Second, as a result of a crisis, policy makers may form coalitions, that is, new agreements among subsets of the players replace the old agreement. For example, a subset of a few Periphery countries may either join an enlarged Center or form a unilateral …xed exchange rate area vis-à-vis the Center (the Core) which systematically excludes the others Periphery countries. The emergence of such coalitions might be more plausible if there is some ex-ante heterogeneity among the Periphery countries. Through the mechanisms analyzed in the discussion of the Nash allocation, the stability of the bilateral exchange rates in the Core vis-a-vis an IS shock in the Center clearly bene…ts from the free ‡oat of the Core vis-à-vis the outsiders' currencies.

9 Interpreting the ERM crisis in a Center-Periphery model

The Center-Periphery model shows that, for a given exogenous shock to the conventional fundamentals, represented by ^{2}, the equilibrium outcome is not independent of the nature and extent of policy coordination in the Periphery of the system. The goal of this section is to explore the contribution of this insight to an understanding of the 92-93 exchange rate crisis.

9.1 The realignment of the lira as a coordination shock

At the end of 1991, it became clear that, in the absence of a realignment in the ERM, the Bundesbank would pursue the goal of price stability by using its interest rate instruments with little regard for the consequences for the domestic real economy and with utter disregard for the international implications of such a policy. Figure 1 provides a striking synthesis of the policy con‡ict between Germany and the other ERM members. The interest rate in Germany increases relentlessly up to the crisis.

This con‡ict, reinforced by the tensions generated by the …rst Danish referendum and the dollar crisis in August, had led, during the summer of 1992, to expectations of a generalized devaluation vis-à-vis the D-Mark, by a magnitude that was variable across country (Italy, Spain and Portugal show the highest interest di¤erentials) but modest overall, and signi…cantly smaller than the magnitudes of the depreciations that were actually realized in the following weeks. In the …rst half of September, a massive speculative attack against the lira took place. Both the adverse cyclical conditions and the increasing public debt to GDP ratio suggested that the Italian government would have welcomed a devaluation. Unless the Bundesbank had stood decisively in defense of the existing parities, a realignment was widely considered unavoidable.

The speculative attack against the lira intensi…ed after the EC meeting in Bath on the 5th and 6th of September, on which occasion the con‡ict on exchange rate matters among European policy makers was widely reported by the press. During the week following the event, the Bundesbank and the Bank of Italy put forward a proposal for a generalized realignment involving a 3.5% revaluation of the D-mark and a 3.5% devaluation of the lira against all other currencies in the ERM (that is, a 7% devaluation of the lira against the D-mark). The realignment should have been matched by a cut in the German interest rates by a magnitude that was to depend on the number of countries joining in the realignment as well as on the size of these realignments.

At …rst sight, the German proposal may look like a bargaining scheme, with the Bundesbank o¤ering a substantial interest rate cut in exchange for a generalized devaluation of the ERM currencies vis-à-vis the D-mark. Our model shows how misleading such an interpretation can be. The German proposal need involve no bargaining or compromise. A decrease in the community-wide interest rate following a generalized realignment is an equilibrium (endogenous) outcome in our model, in which there is no bargaining and the Center (Germany) does not modify its non-cooperative policy strategy vis-à-vis the Periphery. There need not be any quid pro quo involved.

As Germany after reuni…cation was unwilling to modify its policy mix, the

only way in which the rest of the Community could rescue their economies from the adverse domestic implications of high German interest rates was to engineer domestic monetary expansions and depreciate their currencies. This could have been done in a coordinated way, for instance (but not necessarily) along the lines of the German-Italian proposal. In principle, the realignment scheme could have also involved di¤erentiated rates of exchange rate devaluation, to account for heterogeneity among individual Periphery countries.

Note that, according to our analysis, the initial and solitary Italian devaluation by 7% could hardly have been considered to be part of a sustainable equilibrium. Assuming, for the sake of argument, that the Bundesbank proposal could indeed have produced a sustainable ERM-wide parity grid, the devaluation of the lira by 7% would have made sense only in the context of a generalized realignment. As the lira was the only currency to be devalued in a period of rampant rumors and leaks about disagreements and polemics among ERM member countries,[42] the new parity grid established in September 14th 1992 could have hardly been convincing in the eye of …nancial markets.

In the light of these considerations, one should not dismiss the hypothesis that the realignment of the lira on September 14, 1992 was indeed an important component of the shock to the ERM fundamentals, insofar as it conveyed information about a possible change in the rules of the ERM monetary policy game (a switch from cooperative to non-cooperative behavior) and thus led private markets to revise their views on the current and future level of EC-wide interest rates.

With the …rst Italian devaluation it became apparent that German rates would only fall signi…cantly in response to sharp devaluations by a number of other countries. Our model shows that uncoordinated realignments deliver less monetary expansion than coordinated realignments, even if all of the devaluations that characterize the new Nash equilibrium are implemented fully. A fortiori, the uncoordinated realignment(s) of a disequilibrium scenario will deliver rather little system-wide monetary relaxation. Thus, the partial resolution of the uncertainty about the degree of cohesion among the ERM countries clearly pointed to a persistence of relatively high interest rates. Doubts about the sustainability of such a regime must have suddenly grown stronger in quite a few countries. As Padoa-Schioppa [1994] puts it:

> "[the cause of the ERM crisis] was plainly traceable to what in the academic jargon is called a 'co-ordination failure' [...]. There was the refusal to accept a general realignment and even to call a meeting of the Monetary Committee or of the ministers and

> central-bank governors when, in September 1992, a general realignment might have calmed the markets. The general procedure, once embarked on, did not produce a credible new grid. At various time, and in various ways, through unhelpful declarations that excited markets as well as through policy decisions that caused unnecessary friction, the system was destabilized by its very custodians." [43]

9.2 Policy options in Europe and scenarios for the 92-93 crisis

Anecdotal evidence of a low level of cohesion and coordination in the face of the tensions in the ERM in 1992 is overwhelming. It …rst became public knowledge with the devaluation of the lira. Why were European countries unable to agree on coordinated policy action?

At a theoretical level, our model addresses this issue by focusing on potential con‡icts regarding the distributional consequences of a coordinated realignment. A devaluation by one country has a positive external e¤ect on welfare in the rest of the Periphery. There is scope for disagreement and con‡ict about how the costs and bene…ts of coordinated policies are to be distributed among the members of an exchange rate system.

Taking our model at face value, let us focus on the scenario in which, faced with a sizable shock to German demand, symmetric coordination would lead to a generalized defense of the exchange rate regime, while Nash behavior would bring about uncoordinated devaluations by some countries. The …rst bit of relevant evidence is that Germany was keen on implementing a generalized ERM realignment, while being utterly opposed to any revision of its own monetary policy. The second bit of evidence is that apparently no country (with the exception of Italy) was willing to discuss the terms of an ERM-wide realignment, while considerable pressure was put on Germany to do exactly what it did not want to do. In the EC meeting of Bath at the beginning of September 1992

> "Schlesinger was not so much ignored as scorned, says a participant [to the EC meeting in Bath], for his apparent willingness to 'so easily put monetary union at risk' with the …rst ERM realignment since 1987. [...] 'Realignment was a dirty word in Bath' Schlesinger was later bitterly to complain to a German colleague." [44]

As it became absolutely clear that Germany would not give in to the other ERM countries' request to loosen its monetary policy, there were two

possible courses of action open to the Periphery countries. The …rst one was to engage in a possibly very painful defense of the existing parities, at the cost of further domestic de‡ation and worsening …scal imbalances. The second one was to engineer some monetary expansion in the Periphery. This could have been achieved either in a coordinated way (implying bargaining and compromising on whether, and by how much, each particular country should have devalued), or, in the spirit of the brightest libertarian tradition, "each one to his own".

In the second scenario, the question arises as to which countries would have to give in and devalue. Besides the lira, a reasonable set included the pound, the peseta and the escudo. Note that, as far as the French franc is concerned, the uncertainty regarding the political support for the Maastricht Treaty played a role in delaying the speculative attack on this currency until after the referendum result – a tiny majority for the oui to Maastricht.

Perhaps, there was no need at all to guess which particular currency would have been more vulnerable to a speculative attack. Our model predicts that a non-coordinated equilibrium requires a few countries to devalue by a sizable amount; it cannot predict which currencies will be devalued. Thus, each currency is a potential candidate for a devaluation, regardless of how sound its domestic fundamentals look. The rest of the story is well known: during the …rst ten days of the crisis, the lira and the pound withdrew from the ERM, the peseta devalued by 5%, the defense of the French franc required massive intervention by both French and German authorities and Spain, Portugal and Ireland reintroduced temporary capital controls. In the following months, several ERM currencies su¤ered repeated attacks.[45] Substantial devaluations were often the only possible response.

We stress two caveats. The …rst one regards the de…nition of the Center of the system. This, of course, may include more than one country, provided that their monetary policies are fully coordinated. This is the case for Germany, the Netherlands and, to a certain extent, Belgium. The second caveat concerns the evidence of a coalition or cooperative arrangement between Germany and France. France clearly cannot, for the period under consideration, be considered part of the (hard) Center. Yet, unlike all other Periphery countries, which were e¤ectively left to fend for themselves, France bene…ted in the defense of its parity from massive German support, putting it in the special position of belonging to the extended Center or "soft Core" of the system.

With the exception of France, the survival of the ERM was clearly linked, once the crisis had started, to each individual country's willingness to peg its exchange rate to the D-Mark, with little or no intra-community support. The di¢culty of this task was magni…ed by a widespread feeling that the strength

of the political support for Maastricht had somehow dwindled with the …rst Danish referendum. From September 1992 till August 1993, the working of the ERM is well described in terms of uncoordinated attempts to determine the new equilibrium exchange rates, that is, by the (somewhat messy and staggered implementation of the) Nash scenario of our model.

10 The road ahead

In the mid 1990s, we have witnessed something of a shift of support, within both the political and intellectual milieu, from external to internal nominal anchors. It appears rather hard to …nd the same enthusiasm for …xed exchange rate policies that characterized the late 1980s. As a new chapter of European monetary history is being written, the academic debate on its theoretical underpinnings has indeed been increasingly devoted to in‡ation targeting, optimal contracts and central bank independence, with reduced emphasis on target zones and other forms of exchange rate management as stabilization instruments, reputation-building schemes and anti-in‡ationary devices. The crucial turning point a¤ecting intellectual opinions and policy priorities is the crisis of the ERM in 1992/93.

Still, to consider the ERM crisis as the ultimate proof of the unsustainability (or undesirability) of …xed exchange rates is to miss the point. This paper has developed in detail the view that the key event that triggered the collapse of the ERM was a shift in the attitude toward exchange rate and monetary policy coordination and cooperation among European policy makers, and the perception of this shift by market participants. With most of the existing literature, we share the view that — unless the commitment to the exchange rate peg is indeed completely unquestioned — the oxymoron-like "‡exible peg" is in itself destabilizing, and contains the seeds of its own destruction. We do not believe, however, that if a collapse can occur it necessarily will occur. Asymmetric disturbances per se need not be disruptive of international monetary arrangements. Almost by de…nition, a crisis of an exchange rate system is a symptom of insu¢cient or ine¤ective policy coordination.

As regards the implications for the future of the ERM and EMU, what the 1992-93 events have painfully revealed is the intrinsic fragility of the European monetary architecture. What should replace the current (non-) system? The Center is currently showing an uncompromising attitude towards monetary stability in a monetary union. The traditional debate between the "monetarist" and "economist" approach[46] to European monetary issues has long made us aware of the fact that, for the Center (the home of

the 'economist' approach), the 'convergence' process is virtually a goal in its own right, rather than a means to the end of monetary union. The transition towards monetary union, rather than monetary union itself, is the crux of the process. Note that any convergence-centered approach to the transition to monetary union re‡ects a view of monetary union as a coming together of countries that are e¤ectively replicas of each other rather than as a process of integration of heterogeneous economies. The particular further slant given to this approach by the Center in addition makes the convergence process asymmetric, with the state of monetary union to be reached through the addition of homogenized Periphery regions to a pre-existing core on the terms of the core. The statements of German …scal and monetary authorities in the fall of 1995 leave no doubt about their stance on these issues.

Is it possible to replace e¤ective and active policy coordination among European countries with the kind of mechanical policy coordination that is implicitly required by numerical ceilings on public sector debts and by targets for in‡ation rates, exchange rates and interest rates? Despite the well-known objections to the logic and e¤ectiveness of the Maastricht convergence criteria, such tests of good macroeconomic behavior may be useful in fostering good policy management, provided that they are applied sensibly and ‡exibly. After all, solvency, low in‡ation and …nancial stability are reasonable pre-requisites for a country that wants to join a monetary union. An obsessively mechanical reading of the Maastricht criteria, however, tends to focus the attention exclusively on domestic problems, denying the relevance of the issue of reconstructing a system of European monetary cooperation.

One key lesson from the 1992-93 crisis is that, in the absence of e¤ective internalization of the policy spillovers, nominal or real macroeconomic convergence between Center and Periphery do not insulate the system from currency crises. Even if a country were able to satisfy the Maastricht criteria exactly, it could still be vulnerable to speculative attacks. Moreover, recent episodes show that, without cooperation, countries that attempt to achieve convergence may …nd themselves subjected to the …nancial equivalent of the tortures of Tantalus. There are plenty of …nancial shocks beyond the control of a national policy maker that may hamper convergence; careless political statements by in‡uential foreigners are a good example. Through their impact on interest rates, speculative pressures generated by a throwaway comment or an infelicitously timed opinion in Frankfurt can rapidly reduce the e¤ectiveness of domestic policy measures in Rome.

Finally, it is apparent that monetary union, if and when it comes, will initially involve but a strict subset of all EU members. A whole range of Center-Periphery (and intra-Periphery) issues will therefore have to be dealt with. Even though the special problems associated with a two-speed or multi-

speed monetary union are only transitional or temporary, in nature, no one doubts they are likely to be acute. The year 1995 has already given us a taste of the tensions that are likely to arise. We have mentioned before the debate on the "unfair" competitive advantage acquired by weak-currency countries against strong-currency countries as a result of the large devaluations since September 1992. The suggestion was even made that these "competitive devaluations" sanctioned the imposition of countervailing duties within the EU. Rebutted forcefully by several economists (including the EU Commissioner Mario Monti) as inconsistent with the Single Market legislation, the case for "devaluation aid" and compensatory transfers failed to convince the economists and the o¢cials of the Commission, who in the fall of 1995 concluded that, if anything, strong-currency countries such as France, the Benelux and Germany had gained in competitiveness through low in‡ation, lower interest rates and low labor costs.

In historical perspective, political cohesion has been the engine of progress in European economic and monetary integration. Political cohesion is what has traditionally overcome the skepticism of markets as well as the objections of the "experts". The insu¢cient and solitary realignment of the lira in 1992 revealed to both markets and experts that European policy makers were no longer able or willing to give a coherent, coordinated response to monetary tensions. A renewed ability to do so will be the …rst important indicator that the Maastricht design has not been swept away on waves of speculative frenzy.

Appendix

This appendix presents the structure of the model underlying our analysis. All variables other than interest rates are in natural logarithms. All variables referring to the Center country are starred, while the Periphery countries are indexed with a subscript i, for $i = 1; 2; :::; N$. Unless otherwise explicitly stated, Greek letters (both lowercase and uppercase) refer to constant, positive parameters.

A) The Center country Output supply in the Center, denoted by y^{α}, is a deterministic function of employment, n^{α}, subject to decreasing returns to scale:

$$y_t^{\alpha} = (1 \text{ ¡ } ®)n_t^{\alpha} \qquad 0 < ® < 1 \qquad \text{(A.1)}$$

Labor is supplied inelastically, while pro…t-maximizing competitive …rms equate the marginal product of labor to the real wage. The money wage in the Center is denoted w^{α}, while p^{α} is the Center's GDP de‡ator:

$$w_t^{\alpha} \text{ ¡ } p_t^{\alpha} = \text{ ¡ } ®n_t^{\alpha} \qquad \text{(A.2)}$$

Real aggregate demand in the Center depends on the e¤ective real exchange rate of the Periphery vis-à-vis the Center z (de…ned below), the Center's real interest rate r^{α}, and an aggregate demand shock $¸^{\alpha}$:

$$y_t^{\alpha} = ¸_t^{\alpha} \text{ ¡ } ±z_t \text{ ¡ } °r_t^{\alpha} \qquad \text{(A.3)}$$

The real interest rate in the Center is its nominal interest rate i^{α} minus the expected proportional rate of change in its consumer price index, q^{α} :

$$r_t^{\alpha} \text{ ´ } i_t^{\alpha} \text{ ¡ } E_t q_{t+1}^{\alpha} + q_t^{\alpha} \qquad \text{(A.4)}$$

where E_t denotes the expectation operator conditional on information available in period t.

The Center's consumer price index is de…ned as follows. Let $s_{i;t}$ be the nominal spot exchange rate of the i^{th} Periphery country (expressed as i^{th} country's currency per unit of Center's currency) and let s_t be the nominal e¤ective exchange rate of the Periphery vis-à-vis the Center, that is,

$$s_t \text{ ´ } \frac{1}{N} \sum_{i=1}^{N} s_{i;t} \qquad \text{(A.5)}$$

Given the assumption of symmetry, in eqn.(A.5), the e¤ective nominal exchange rate is simply the arithmetic average of the nominal exchange rates

in the Periphery. Similarly, let $p_{i;t}$ be the GDP deflator of the i^{th} Periphery country (in local currency). The real exchange rate of the Periphery country i vis-à-vis the Center is defined as

$$z_{i;t} = s_{i;t} - p_{i;t} + p^{*}_{t} \tag{A.6}$$

The effective real exchange rate of the Periphery vis-à-vis the Center, z, is then given by

$$z_t \equiv \frac{1}{N} \sum_{i=1}^{N} z_{i;t} \tag{A.7}$$

It is convenient to define p_t the "effective price level" of the Periphery as a whole, measured in the Center's currency, that is,

$$p_t \equiv \frac{1}{N} \sum_{i=1}^{N} (p_{i;t} - s_{i;t}) \tag{A.8}$$

Assuming a constant share of imports in consumption, γ (which applies to each of the Periphery countries as well as to the Center), the Center's CPI is defined as follows

$$q^{*}_t \equiv (1-\gamma)p^{*}_t + \gamma p_t = p^{*}_t - \gamma z_t \qquad 0 < \gamma < \frac{1}{2} \tag{A.9}$$

We restrict the propensity to import γ to be less than one half, which is equivalent to assuming home bias in consumption in our model. As will become clear later, this assumption rules out the possibility that real interest differentials and real expected depreciation between Center and Periphery move in opposite directions.

Assuming a constant velocity money demand function, equilibrium in the money market requires

$$m^{*}_t = p^{*}_t + y^{*}_t = w^{*}_t + n^{*}_t \tag{A.10}$$

where m^{*} denotes the Center's nominal money stock. At the end of period $t-1$, that is before the Center money stock m^{*}_t is determined and observed, wage setters choose the money wage prevailing in period t. Their objective function is to minimize the forecasted deviation of employment from the full-employment level (here normalized to zero). Therefore, they solve

$$\min_{w^{*}_t} E_{t-1} \frac{1}{2} (n^{*}_t)^2 \tag{A.11}$$

subject to eqn.(A.10). Since $n_t^{\natural} = m_t^{\natural} - w_t^{\natural}$; this implies that nominal wages are equal to the expected money supply, and employment (or output) is function only of monetary innovations:

$$w_t^{\natural} = E_{t-1} m_t^{\natural} \tag{A.12}$$

$$n_t^{\natural} = m_t^{\natural} - E_{t-1} m_t^{\natural} \tag{A.13}$$

B) The Periphery countries Periphery countries have the same technology as the Center. Thus, using self-explanatory notation, the supply-side equations characterizing the Periphery are given below.

$$y_{i;t} = (1 - \alpha) n_{i;t} \tag{A.14}$$

$$w_{i;t} - p_{i;t} = -\alpha n_{i;t} \tag{A.15}$$

We assume that Periphery countries import (export) goods and services exclusively from (to) the Center country. This is the reason why only the bilateral real exchange rate of country i relative to the Center, z_i, enters into the demand equation for country i^0s output:

$$y_{i;t} = \gamma + \delta z_{i;t} - \sigma r_{i;t} \tag{A.16}$$

Different from the demand equation in the Center country (A.3), the parameter γ in equation (A.16) is constant. In other words, we abstract from country-specific and time-specific IS shocks hitting the Periphery countries. The only source of exogenous uncertainty is therefore a perturbation of aggregate demand in the Center, which affects all Periphery countries symmetrically. The other behavioral parameters δ; σ and $\bar{\ }$ are identical in both the Center and the Periphery.

Real interest and exchange rates in the i^{th} country are

$$r_{i;t} = i_{i;t} - E_t q_{i;t+1} + q_{i;t} \tag{A.17}$$

$$q_{i;t} = p_{i;t} + \bar{z}_{i;t} \tag{A.18}$$

By analogy with the Center, real money balances, money wages and employment in the Periphery are determined as follows

$$m_{i;t} - p_{i;t} = y_{i;t} \tag{A.19}$$

$$w_{i;t} = E_{t-1} m_{i;t} \tag{A.20}$$

$$n_{i;t} = m_{i;t} - E_{t-1} m_{i;t} \qquad (A.21)$$

We …nally assume that assets denominated in di¤erent currencies are perfect substitutes in private agents' portfolios, so that the uncovered interest parity condition holds:

$$i_{i;t} = i^{\star}_t + E_t s_{i;t+1} - s_{i;t} \qquad (A.22)$$

Note that, given (A.22), with perfect capital mobility the uncovered interest parity condition must hold for any pair of currencies in the system.

C) Shocks to fundamentals, monetary innovations and the real exchange rate In this section, we present a semi-reduced form of our model, expressing all endogenous variables as functions exclusively of exogenous, predetermined or control variables. First, consider the bilateral real interest rate di¤erential between the i^{th} country and the Center country

$$r_{i;t} = r^{\star}_t - \bar{\gamma}(E_t z_{t+1} - z_t) + (1 - \bar{\gamma})(E_t z_{i;t+1} - z_{i;t}) \qquad (A.23)$$

By taking the sum over the N periphery countries, the average interest rate di¤erential between the Periphery and the Center will be

$$\frac{\sum_i r_{i;t}}{N} = r^{\star}_t + (1 - 2\bar{\gamma})(E_t z_{t+1} - z_t) \qquad (A.24)$$

According to the previous expression, the real interest rate di¤erential and the expected rate of depreciation of the real exchange rate between Center and Periphery move in the same direction if and only if $\bar{\gamma} < 1/2$, that is, if there is home bias in consumption (see eqn.(A.9)). We maintain this assumption throughout.

A few intermediate steps are helpful to characterize the reduced form equation for the Center's e¤ective real exchange rate. First, using eqn.(A.24) together with the aggregate demand functions (A.3) and (A.16), and the resource constraint of the economy as a whole,

$$\frac{\sum_i y_{i;t}}{N} - y^{\star}_t = (1 - \alpha)\left(\frac{\sum_i n_{i;t}}{N} - n^{\star}_t\right) \qquad (A.25)$$

we obtain a …rst order stochastic di¤erence equation in z_t:

$$z_t = \delta E_t z_{t+1} + \Lambda\left(\frac{\sum_i n_{i;t}}{N} - n^{\star}_t\right) - \frac{\omega}{\sigma(1 - 2\bar{\gamma})}(\varepsilon - \varepsilon^{\star}_t) \qquad (A.26)$$

where

$$\delta \equiv \frac{\nu(1 - 2\bar{\gamma})}{2\pm + \nu(1 - 2\bar{\gamma})} < 1 \qquad \Lambda \equiv \frac{1 - \alpha}{2\pm + \nu(1 - 2\bar{\gamma})} \qquad (A.27)$$

As the e¤ective real exchange rate z_t is a forward looking variable, we impose a no-bubble terminal condition. Solving equation (A.26) with such a boundary condition yields

$$z_t = Á \left(\frac{\sum_i n_{i;t}}{N} ¡ n_t^¤ \right) + ²_t \qquad (A.28)$$

where $²_t$ is de…ned as

$$²_t ´ \frac{°}{v(1 ¡ 2^{-})} \sum_{¿=0}^{1} °^¿ E_t(¸^¤_{t+¿} ¡ ¸) \qquad (A.29)$$

The e¤ective real exchange rate depends both on the di¤erence between the current monetary innovations in the Periphery and in the Center (which equals the di¤erence between the employment levels in the Periphery and the Center) and, through the forward looking variable $²_t$, on current and expected future real demand shocks in the Center relative to the Periphery. Thus, a demand (IS) shock in the Center larger than in the Periphery causes the Center's real exchange rate to appreciate, while a money supply shock in the Center larger than in the Periphery causes the Center's real exchange rate to depreciate. The stochastic variable $²_t$ is the exogenous shock to the fundamentals of our international economy. It bears emphasizing that the current realization of $²_t$ is the present discounted value of current and expected future demand disturbances over the in…nite horizon.

D) Bilateral real exchange rates and real interest rates Next, it is straightforward (albeit algebraically tedious) to show that the bilateral real exchange rate of Periphery country i vis-à-vis the Center is

$$z_{i;t} = »(1 ¡ µ) n_{i;t} + @²_t ¡ »µ \sum_{j \in i} n_{j;t} ¡ Án_t^¤ A \qquad (A.30)$$

where the parameters µ and » are de…ned as

$$µ ´ Ã \frac{± ¡ °^{-}}{2± + °(1 ¡ 2^{-})} ! \frac{1}{N}; \qquad » ´ \frac{1 ¡ ®}{± + °(1 ¡ ^{-})} = \frac{Á}{1 ¡ Nµ} > 0 \qquad (A.31)$$

Note that the sign of µ is ambiguous.

Using (A.16) and (A.30), the semi-reduced form of the real interest rate in country i becomes

$$r_{i;t} = \frac{1}{o} \left\{ ¸ + [±»(1 ¡ µ) ¡ (1 ¡ ®)] n_{i;t} + ±@²_t ¡ »µ \sum_{j \in i} n_{j;t} ¡ Án_t^¤ A \right\} \qquad (A.32)$$

Inspection of equation (A.32) brings out an important feature of our framework: for given monetary policies in the rest of the system, n_t^{α} and $\sum_{j \neq i} n_{j;t}$, the spillovers from a positive demand shock in the Center result in an increase of the real interest rate in country i. That is to say, positive demand shocks in the Center country directly translate into negative demand shocks in the Periphery through their e¤ect on the real interest rate.

Finally, it is useful to write the semi-reduced form equations for the CPI as

$$q_{i;t} = [\theta + \beta(1 - \mu)]\, n_{i;t} + w_{i;t} + \beta \left(\varepsilon_t - \gamma \mu \sum_{j \neq i} n_{j;t} - \Delta n_t^{\alpha} \right) \tag{A.33}$$

and the bilateral nominal exchange rate vis-à-vis the Center as

$$s_{i;t} = [\theta + \gamma(1 - \mu)]\, n_{i;t} + w_{i;t} - w_t^{\alpha} - \theta n_t^{\alpha} + \varepsilon_t - \gamma \mu \left(\sum_{j \neq i} n_{j;t} - \Delta n_t^{\alpha} \right) \tag{A.34}$$

Other things equal, a depreciation of its nominal exchange rate raises both employment and the CPI in country i.

In the main text, we adopt the following notational simpli…cations:

$$\theta_0 \equiv \theta + \beta(1 - \mu) \tag{A.35}$$

$$\theta_1 \equiv \gamma \mu \tag{A.36}$$

$$\theta_2 \equiv \theta + \gamma(1 - \mu) \tag{A.37}$$

$$\lambda_{i;t} \equiv \varepsilon_t - \theta_1 \sum_{j \neq i} n_{j;t} - \Delta n_t^{\alpha} \tag{A.38}$$

It is therefore immediate to derive equations (1) and (2) in the main text by rearranging equations (A.33) and (A.34) above.

E) Equilibrium devaluation thresholds To determine the devaluation thresholds, we proceed as follows. First, we write the formula for the shadow devaluation rate as:

$$\phi s_{i;t} = \frac{\theta_i + (A - \alpha)\, w_{i;t} + (A - \beta\alpha)\, \lambda_{i;t} + \alpha q_{i;t} - A s_{i;t}}{A} \tag{A.39}$$

where

$$A = \frac{1 + \beta\theta_0^2}{\theta_2} \qquad \alpha = \beta\theta_0. \tag{A.40}$$

Second, market participants' wage expectations can be rewritten by rearranging eqn.(20) as a function of a given threshold $\bar{\upsilon}_{i,t}$

$$w_{i,t} = E_{t-1} m_{i,t} = (1 - \pi_{i,t}) A \left(\frac{\bar{s}_{i,t} - [E\upsilon_{i,t} | \upsilon_{i,t} < \bar{\upsilon}_{i,t}]}{(1 - \pi_{i,t})A + \pi_{i,t}\delta} \right) +$$

$$+\pi_{i,t} \left(\frac{\bar{n}_i + \delta(\bar{q}_{i,t} - \beta[E\upsilon_{i,t} | \upsilon_{i,t} \geq \bar{\upsilon}_{i,t}])}{(1 - \pi_{i,t})A + \pi_{i,t}\delta} \right) \tag{A.41}$$

Third, we replace $w_{i,t}$ in the definition of the shadow devaluation rate $\Delta\tilde{s}_{i,t}$ with expression (A.41). Rearranging the realignment rule (18), country i will devalue its currency if the following condition holds:

$$\left(\frac{A - \beta\delta}{A} \right) \upsilon_{i,t} + \left[\frac{\bar{n}_i + \delta(\bar{q}_{i,t} - \bar{s}_{i,t})}{(1 - \pi_{i,t}) A + \pi_{i,t}\delta} \right] -$$

$$- \left(\frac{A - \delta}{A} \right) \left[\frac{(1 - \pi_{i,t}) A [E\upsilon_{i,t} | \upsilon_{i,t} < \bar{\upsilon}_{i,t}] + \pi_{i,t}\delta\beta [E\upsilon_{i,t} | \upsilon_{i,t} \geq \bar{\upsilon}_{i,t}]}{(1 - \pi_{i,t}) A + \pi_{i,t}\delta} \right] \geq \tilde{c}_i \tag{A.42}$$

This is the key-expression to the endogenous identification of the devaluation threshold $\bar{\upsilon}_{i,t}$, so far taken as a given parameter. The equilibrium interior value(s) of the devaluation threshold under rational expectations can be found by taking expression (A.42) to hold with equality and solving for $\upsilon_{i,t} = \bar{\upsilon}_{i,t}$.

F) Multi-country Nash equilibrium Our three-step solution strategy focuses on equilibrium outcomes involving (possibly) devaluations by some countries. First, conjecture the existence of a realization of the shock, say $\varepsilon = \hat{\varepsilon}$, such that each Periphery country is indifferent between maintaining the peg and abandoning it. By conditions (18), it is obvious that this is possible if and only if the SDR — eqn.(A.39) above — is equal to $\tilde{c}$ for each country in the Periphery, when evaluated at $\hat{\varepsilon}$:

$$\Delta\tilde{s}_i[\hat{\varepsilon}] = \tilde{c} \qquad i = 1, 2, ..., N \tag{A.43}$$

Given that the Periphery countries are indifferent between a peg and a float, denote by N^{FL} the number of countries that decide to realign. Since the countries that choose to abandon the peg devalue (optimally) by a percentage $\tilde{c}$, the average actual depreciation rate is

$$\frac{1}{N} \sum_{i=1}^{N} (s_i - \bar{s}) = \frac{N^{FL}}{N} \Delta\tilde{s}_i[\hat{\varepsilon}] = \frac{N^{FL}}{N} \tilde{c} \tag{A.44}$$

Second, consider the aggregate reaction function of the Periphery, namely

$$\frac{\sum_i n_i}{N} = \frac{1}{\beta_2}\left[\frac{\sum_i s_i}{N} - \varepsilon - \frac{\sum_i w_i}{N} + \beta_1 (N-1)\frac{\sum_i n_i}{N}\right] \qquad \text{(A.45)}$$

Using eqn.(A.44), it is possible to evaluate the previous expression at $\varepsilon = \bar{\varepsilon}$. Solving for the average employment rate in the Periphery yields

$$\frac{\sum_i n_i}{N}(\bar{\varepsilon}) = \frac{1}{\beta_2 - \beta_1 (N-1)}\left[\frac{N^{FL}}{N} - \bar{\varepsilon} + \frac{\sum_i (s_i - w_i)}{N}\right] \qquad \text{(A.46)}$$

Third, consider the shadow devaluation rate (A.39) and take its average across Periphery countries. For our conjecture to be true, it must be the case that

$$\frac{\sum_i \phi s_i}{N}(\bar{\varepsilon}) = \bar{e} = \frac{1}{A}\left[\bar{m} + (A-\alpha)\frac{\sum_i w_i}{N} + \right.$$
$$\left. + (A-\bar{\alpha})\bar{\varepsilon} - \beta_1 (N-1)\frac{\sum_i n_i}{N}(\bar{\varepsilon}) + \alpha\frac{\sum_i \phi_i}{N} - A\frac{\sum_i s_i}{N}\right], \qquad \text{(A.47)}$$

where A and α are the parameters de…ned in eqn.(A.40) above. Substituting eqn.(A.46) into (A.47) and rearranging, the percentage of countries that in equilibrium must abandon the peg is given by

$$\frac{N^{FL}}{N} = \frac{1}{\theta_3}\left[\bar{m} + \theta_1 \bar{\varepsilon} - \theta_2 \sum_{i=1}^{N}\frac{s_i - w_i}{N} - \alpha \sum_{i=1}^{N}\frac{w_i - \phi_i}{N} - A\bar{e}\right] \qquad \text{(A.48)}$$

where the θ's coe¢cients are functions of the parameters of the model, as summarized below:

$$\theta_1 = \frac{\beta_2 (A-\bar{\alpha})}{\beta_2 - \beta_1 (N-1)} = (A-\bar{\alpha})\left[1 + \frac{\mu (N-1)}{\beta + \delta}\right]$$

$$\theta_2 = A + \frac{\beta_1}{\beta_2}(N-1)\theta_1 \qquad \theta_3 = \theta_2 - A \qquad \text{(A.49)}$$

The proportion of countries abandoning the peg in equilibrium is a linear function of target exchange rate, the target price level, the predetermined wage rates and the realization of the shock. As we conjectured, equation (A.48) implies that each country is indeed indi¤erent between abandoning or maintaining the announced exchange rate parity, provided that the required number of countries N^{FL} devalue in the aggregate (for expositional convenience, we ignore the constraint that N^{FL} be an integer). Note that, with ex-ante identical countries, it is not possible to determine which particular countries will implement a devaluation.

Nonetheless, the range of shocks for which our conjecture is valid is limited by the fact that N^{FL} must lie between 0 and the number of Periphery countries. The boundaries of this range can thus be determined by setting $N^{FL} = 0$ and $N^{FL} = N$ in equation (A.48), and solving for the corresponding threshold values, $\underline{\varepsilon}^{d}$ and $\bar{\varepsilon}^{d}$. For shocks larger than $\bar{\varepsilon}^{d}$, all countries in the Periphery will devalue by the same optimal rate $\Delta s_{i,t} > e$. For shocks smaller than $\bar{\varepsilon}^{d}$, the Periphery countries will maintain the peg.

G) Cooperative equilibrium under the national horizontal equity constraint The optimal monetary policy in the case of coordinated symmetric behavior of the N countries in the Periphery implies the following reaction functions: if $\Delta s_i^{CS} \leq e^{CS}$,

$$n_i = \frac{(s_i - w_i)}{\alpha + \gamma} \tag{A.50}$$

while if $\Delta s_i^{CS} > e^{CS}$,

$$n_i = \frac{(s_i + \Delta s_i^{CS} - w_i)}{\alpha + \gamma}. \tag{A.51}$$

Under symmetric cooperation, the relevant shadow devaluation rate is

$$\Delta s_i^{CS} = \frac{1}{A^{CS}} \left[\theta + \left(A^{CS} - \bar{\omega}^{CS} \right)^2 + A^{CS}(w_i - s_i) - \omega^{CS}(w_i - q_i) \right] \tag{A.52}$$

where

$$A^{CS} \equiv \frac{1 + \phi(\alpha + \bar{\gamma})^2}{\alpha + \gamma} \qquad \omega^{CS} \equiv \phi(\alpha + \bar{\gamma}) \tag{A.53}$$

Solving for the equilibrium yields the following condition: the Periphery will jointly devalue for $\varepsilon > \bar{\varepsilon}^{CS}$, and jointly maintain the peg for $\varepsilon \leq \bar{\varepsilon}^{CS}$. The threshold of the shock at which a generalized devaluation occurs is easily obtained as

$$\bar{\varepsilon}^{CS} \equiv \frac{A^{CS} e^{CS} - \theta - A^{CS}(w_i - s_i) + \omega^{CS}(w_i - q_i)}{A^{CS} - \bar{\omega}^{CS}} \tag{A.54}$$

Notes

[1]For a reconstruction and chronology of the ERM events see Kenen [1995], ch.7, and Buiter, Corsetti and Pesenti [1996], ch.3.

[2]The standard references are Hamada [1976], Cooper [1985], Buiter and Marston [1985] and Canzoneri and Henderson [1991]. Recent developments are surveyed in Currie and Levine [1993], Ghosh and Masson [1994] and Persson and Tabellini [1995].

[3]As Begg and Wyplosz [1993] write, "despite inconclusive formal evidence, most students of the EMS have accepted the German dominance hypothesis. The frequency of this conclusion seems to arise from the usual view that if you don't see what you believe then buy adequate glasses" (p.23).

[4]Among the most recent cases, it is worth recalling that in 1995 French and Belgian industries – and a number of leading politicians from these two countries – have been bitterly complaining about the competitive advantage acquired by British, Italian and Spanish industry as a result of the large devaluations since September 1992. As an example, according to the estimates (reported by the Financial Times, September 18, 1995) by Jacques Calvet, head of Peugeot, for every 1 per cent fall in the value of the lira or sterling, the company's pre-tax profits fell by between FFr35m and FFr140m.

[5]See e.g. Canzoneri and Henderson [1991].

[6]However, note that an increase in wages is directly inflationary but indirectly deflationary, as it reduces employment and therefore domestic prices along the short-run Phillips curve.

[7]See Appendix A and B.

[8]For future reference, the formula for ε_t as the innovation to the present discounted value of the demand shock is:

$$\varepsilon_t \equiv \frac{\gamma}{\kappa(1-2\beta)} \sum_{\tau=0}^{\infty} \gamma^{\tau} E_t(\xi^*_{t+\tau} - \xi)$$

Here ξ^*_t is the IS shock in the Center during period t, ξ is the common value of the IS 'shock' in the Periphery, and γ; κ and β are positive parameters with $\beta < 1/2$ and $\gamma < 1$. See Appendix C for details.

[9]When we move from the partial-equilibrium approach considered so far to general-equilibrium considerations, it should be clear that the policy stance of every country in the system is jointly determined as a function of the exogenous shock to fundamentals ε_t.

[10]In choosing the policy target $\bar{q}_{i,t}$ and $\bar{s}_{i,t}$, the policy maker is aware of the link between them: for a given value of the Center's GDP deflator p^*_t, fixing $\bar{q}_{i,t}$ and $\bar{s}_{i,t}$ is equivalent to targeting some level of the real exchange rate. In principle, one could use this fact to explore the implications of choosing an "incorrect", misaligned exchange rate target. However, in what follows we

shall rather focus on the case where there is no inescapable con‡ict between the objectives for the internal and the external value of the currency. The country therefore targets $q_{i;t} = s_{i;t} + p^{*}_{t}$:

[11] As we discuss below, p^{*}_{t} is a constant (normalized to zero) in our model.

[12] Indeed, most analyses of international monetary games, including our own in Buiter, Corsetti and Pesenti [1995] and [1996], focus precisely on the case in which the Center country targets the CPI and not the de‡ator.

[13] With predetermined wages, country j's GDP de‡ator increases with its nominal money stock, but less than proportionally and its real output expands. The increase in aggregate demand that matches the increase in supply requires a real depreciation and a fall of the real interest rate.

[14] In our model, all goods market interaction among the Periphery passes through the Center. If the fall in the demand for the Center's output is large responding to a depreciation of country j's bilateral real exchange rate, for a given domestic supply in the Center, the real interest rate will have to fall substantially to clear the market for Center output. This decline in the real interest rate is transmitted to the other Periphery countries. They now face excess demand at their old bilateral real exchange rate with the Center and will experience a real appreciation. Similar considerations apply also in the more general case in which intra-Periphery trade is considered.

[15] The result depends on the relative size of the elasticities of aggregate demand with respect to the real interest rate and the real exchange rate, normalized by the (constant) share of income devoted to domestic consumption.

[16] See for instance Frankel [1988] and Ghosh and Masson [1994], ch.2.

[17] In principle, the identi…cation of an optimal monetary policy is rather di¢cult when the objective functional of the policy maker is de…ned over an in…nite horizon. Nonetheless, in our setup the intertemporally optimal policy is obtained by taking into account the single-period loss function $\grave{}_{i;t}$ only. Among the features of our model which allow this considerable simpli…cation of the analysis, note that current and anticipated future policy actions are assumed not to be a¤ected by the past history of the game (that is, the actual sequences of past policy actions).

[18] See Appendix E, eqn.(A.39).

[19] The constant can be shown to be equal to the square root of $2c_i = (1 + ¾®^2_0)$:

[20] The escape clause speci…ed in our analysis does not preclude the possibility of a revaluation of the central parity as well as of a devaluation. We simplify the analysis by considering realizations of the shock for which the relevant alternative for the country i's policy makers is between a peg and a devaluation against the Center. In other words, we restrict the support of the shock to be such that a revaluation by country i will never be optimal, ruling

out by construction shocks to fundamentals that would correspond to large negative value of the shadow depreciation rate (so that ¢s$_{i;t}$ ¸ ¡e$_i$). The extension to the general case is simply a corollary of the analysis to follow.

[21]See the discussion in Cavallari and Corsetti [1996].

[22]See also Obstfeld [1994].

[23]See the discussion in Eichengreen and Wyplosz [1993].

[24]See for instance Champa and Chang [1995] and Kenen, Mercurio and Pesenti [1996].

[25]See, for instance, Eichengreen, Rose and Wyplosz [1994].

[26]Note that, on logical grounds, the fact that fundamentals do not seem to di¤er before and after a currency crisis can be alternatively interpreted as evidence against an interpretation based on self-ful…lling speculative attacks. It is su¢ciently clear, at least since Obstfeld [1986], that multiple instantaneous equilibria are based on the policy maker validating ex-post the initial private sector conjectures. To the extent that monetary and interest rate policy is among the fundamentals, these should indeed di¤er after the crisis in the presence of a successful self-ful…lling attack.

[27]For a discussion, see Gros and Thygesen [1992].

[28]In the reconstruction of Muehring [1992], "near the end of the conference in the British spa town of Bath on Saturday, September 5, British Chancellor of the Exchequer Norman Lamont asked Bundesbank president Helmut Schlesinger once more for a commitment to cut German interest rates, which could be included in the postmeeting communiqué. Schlesinger, containing his mounting anger, replied that it was impossible. When Lamont continued to press him, the normally un‡appable Bundesbank president suddenly stood up to leave, only to be restrained by an almost equally annoyed Theo Waigel, the German …nance minister. 'My dear Norman, - Waigel snapped - you have asked us that question four times, and four times we have given you the same answer. We do not see the need for wasting any more time. So if you ask again, I will get our helicopter ready to take us back'." In private conversation, Schlesinger recalls to have said: "The Bundesbank committee decided the day before not to lower, but authorized me to say that we would not increase".

[29]In the case of France, one could nonetheless argue that the incipient loss of competitiveness was suppressed through a high and rising unemployment rate, which created doubts about the political sustainability of the franc fort policy.

[30]Player j's action, n_j, is a strategic complement with respect to player i's action n_i ($i \neq j$) if the magnitude of the optimal action of player i increases whenever player j increases the magnitude of her action, that is, if and only if $@n_i=@n_j > 0$ (see Bulow, Geanakoplos and Klemperer [1985]): In the two-

player case the reaction curve of player i would be upward-sloping. When α_1 is negative, then $\partial n_i/\partial n_j < 0$; country j's action is instead a strategic substitute with respect to country i's action.

[31] It can be easily shown that $\partial \phi s_i/\partial n_j < 0$ if $\alpha_1 > 0$.

[32] Formally, the response of country i's welfare to a monetary expansion in country j conditional on both countries letting their currencies float can be calculated by differentiating country i's loss function with respect to country j's employment, and evaluating this expression at the equilibrium level of employment and prices under a float:

$$\partial \ell_i^{FL}/\partial n_j = -\gamma \left[q_i^{FL} - \phi_i \right] \alpha_1$$

If the support of fundamentals shocks ε is such that revaluations are never optimal, the Nash equilibrium price level will be above its target level ϕ_i (and Nash equilibrium employment will be below its target level $\bar{n}$). The expression above is therefore negative for large ε when α_1 is positive: a monetary expansion in country j increases welfare in country i.

[33] Such assumption is obviously based on positive, not normative, considerations.

[34] A discussion of the historical role of a (strong form of) national horizontal equity is in De Cecco [1988]. The author focuses on the hypothesis according to which cooperative actions are pursued only if they preserve the relative positions, in terms of economic and political power, of the four main members of the EMS. A general discussion of distributive issues and economic integration is in Guerrieri and Padoan [1988].

[35] If the Periphery countries were not all equal ex-ante, this constraint could be generalized to the requirement of "fair" outcomes (ex-post), such that no Periphery country would tolerate a cooperative action that reduces its welfare (relatively to other countries) below some predetermined level, unanimously agreed upon.

[36] Note that the literature on EMU mainly discusses international transfers in the framework of the theory of optimal currency areas. International transfers contingent on relative aggregate demand can help reduce the short-run cost of IS shocks due to domestic nominal rigidities in a fixed exchange rate system, thus increasing the stability and viability of the system. At a theoretical level, our model highlights a different role of contingent international transfers, as side-payments that could make asymmetric coordinated policies feasible by compensating the countries that sustain the largest adjustment costs in a realignment. While in principle sound, however, the assumption of intra-Periphery side-payments of the kind required to support cooperation with nationally differentiated policy actions would hardly be defensible on empirical grounds.

[37] The nearest we get to such exchange rate cooperation-contingent transfers are the Monetary Compensatory Amounts (MCA's) of the Common Agricultural Policy. Even they don't …t the bill, on closer inspection, as they (a) are limited to the agricultural sector and (b) are not contingent on the implementation of cooperative exchange rate policies, but simply respond to gaps between the value of the Green currency and the value of the actual currency, regardless of the nature of the exchange rate arrangements that generates these gaps.

[38] See the discussion in Giavazzi and Giovannini [1989].

[39] In terms of the notation adopted in the Appendix, e^{CS} is equal to the square root of $2c(® + Á) = A^{CS}$:

[40] Figure 6a shows the possibility that, for some con…guration of parameters (implying a stronger in‡ationary bias than in Figure 6b), the trigger point for a generalized devaluation under symmetric cooperation is lower than the threshold at which at least one country realigns under Nash. In this case, a cooperative agreement delivers less exchange rate stability for any level of the shock in the Center. Policy makers will bene…t in this case from "smooth" and frequent realignments (a familiar pattern during the early stages of the ERM).

[41] This question of course points at political economy considerations, stressing the role of policy makers' changing attitudes towards the international agreement.

[42] As Peter Kenen [1995] writes, "the Germans were apparently interested in a more general realignment but pursued the matter rather casually — too casually perhaps to impress the French with the urgency of the issue... It may be objected that France would have vetoed a general realignment, even if France had pressed for one, because the French believed that the franc was immune to contagious speculation. What would have happened, however, if the German chancellor had warned the French president that the Bundesbank could not be expected to support the franc — if he had called attention to the so-called Eminger letter. (One might also ask what would have happened if the German chancellor, not the Italian prime minister, had telephoned John Major about the devaluation of the lira — and added the same sort of warning about future Bundesbank support for the pound)" (p.160).

[43] Padoa-Schioppa [1994], p. 14-15.

[44] Muehring [1992], p. 7.

[45] Similar problems were also faced by both Scandinavian countries that kept their currencies pegged against the mark, obviously not because of the disappearance of faith in the willingness and ability of the ERM members to cooperate in the defense of the peg, as no such (implicit) agreement to

cooperate ever existed for them. Country-speci…c triggers were undoubtedly part of the explanation (the collapse of its trading arrangements with the FSU for Finland and the collapse of domestic consumption demand for Sweden). Bandwagon and contagion e¤ects may also bear some of the blame.

[46] In the intellectual history of European monetary integration, two schools of thought have been contrasted with each other, at least since the time of the Werner Report. The …rst one advocates gradualism in the implementation of the institutional reforms and in the change of policy regimes. Gradualism here means that the process of integration is primarily a process of convergence of economic structure and performance in di¤erent countries, to be matched, and indeed followed by, appropriate institutional developments. The second school instead stresses the role of institutional innovations in promoting economic integration, and advocates …xed deadlines and unconditional institutional reforms which would lead and encourage the behavioral changes required for convergence. Perhaps with little semantic justi…cation, supporters of the …rst school are traditionally labelled "economists", as opposed to the "monetarists" populating the rival intellectual habitat.

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