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INFLATION AND THE E M S

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Abstract

Since the European Monetary System was instituted in March 1979, there has been a dramatic reduction in the inflation rates of member countries. This development is widely attributed to the EMS itself. The purpose of this paper is to argue that the theoretical and empirical basis for such a claim is far from conclusive.

On the theoretical side, the paper develops a model which highlights two issues. First, changes in the "rules" of the exchange rate system need not coincide with changes in expectations about Central Bank behavior. In fact, expectations in France do not seem to have changed until policy makers "got tough" in 1982-83. Second, different researchers have made quite different assumptions about exactly what "rules" the EMS imposes. The paper shows that how the system works matters in terms of the effect joining will have on inflation.

On the empirical side, the paper shows that effects which have been attributed to the EMS are in large part due to the global deflation since 1979 and to the fact that EMS members had relatively low inflation before 1979. However, even these estimates should be interpreted with caution. They are very sensitive to time period and to which nonEMS countries are included in the sample.

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I. Introduction

In 1978, the year before the European Monetary System (EMS) was instituted, (CPI) inflation averaged 7.2% among the soon-to-be members. The rates ranged from 2.7% in Germany to 12.0% in Italy. Inflation rates rose even further during 1979-80, as a result of the second oil shock. By the end of 1986, average EMS inflation had fallen to 2.4%, and the range had narrowed considerably: -0.2% in Germany and 5.9% in Italy. The timing of these developments suggests what I will call the "EMS-Inflation Hypothesis" - that the EMS itself may have been responsible for the inflation reduction and convergence which member countries have experienced.

There seems to be growing consensus that the EMS-Inflation Hypothesis is true. To give two examples, the Wall Street Journal recently stated without qualification that "the EMS has had its successes, such as helping to bring inflation in the other countries down toward the low level prevailing in West Germany." (September 8, 1987) Giavazzi and Pagano (1987) assert that "the central issue is not whether the EMS is an effective disciplinary device for inflation-prone countries.... It is obvious that their inflation will be lower inside than outside the EMS."

In contrast, early studies of the EMS found little evidence supporting the Hypothesis. Rogoff (1985) analyses data through March, 1984. He concludes that:

> "the formation of the EMS did not produce a rapid convergence of inflation rates. ... there is no evidence whatsoever of any convergence between France's, Germany's and Italy's inflation rates ... any convergence that took place was between the inflation rates of Germany, Japan and the United Kingdom. ... Even if French, German and Italian inflation do ultimately converge at a low level, one should be cautious in attributing this success to the existence of the EMS." (p. 96)

Padoa Schioppa (1985) and Ungerer et. al. (1983) are more optimistic, but also find little evidence for the Hypothesis.

The purpose of this paper is to ask whether existing theoretical and empirical evidence supports the current consensus that the EMS-Inflation Hypothesis is true. It is difficult to test the proposition conclusively, because to do so would require comparison of the actual inflation experiences of member countries to a counterfactual- the inflation that these countries would have experienced if they had not joined the EMS. A simple comparison of pre and post EMS experiences is inadequate for a number of reasons, in particular, because external shocks were quite different in the two periods. Similarly, a simple comparison of member and nonmember country experiences is inadequate because the economic structures of the two groups of countries is likely to be quite different. None-the-less, it would seem sensible to believe the Hypothesis only if the evidence (both theoretical and empirical) consistently supports an affirmative conclusion.

Why should the EMS help to reduce inflation? The usual argument is that membership in the EMS provides additional "discipline" to Monetary Authorities in inflation-prone countries. The key channels of this "discipline" are perhaps best illustrated in the theoretical model developed by Giavazzi and Pagano (1987). In their framework, joining the EMS forces policy makers to accept a higher cost to expansionary policy through real appreciation. Realignments are assumed to devalue the currencies of above-average inflation members by at most enough to restore Purchasing Power

Parity (PPP).[1] Therefore, monetary expansion causes inflation which leads to a real appreciation (until the next realignment), and the loss in competitiveness reduces output. It is not surprising that inflation will be lower in this regime that in a flexible exchange rate regime which maintains PPP throughout, regardless of the domestic inflation rate.

The model very intuitively illustrates two key channels for "discipline". First, it provides the Central Bank with added incentives to remain tough and to stick to an austerity program. Second, it increases Central Bank credibility when austerity is announced. A familiar theme in theoretical macroeconomic literature is precisely that the costs of disinflation will be smaller when domestic residents believe that the program will actually be followed.[2]

However, the paper can not tell us whether joining the EMS is likely to reduce inflation, because the theoretical framework begins with this as an assumption. Taking the EMS-Inflation Hypothesis as a given, the authors' interest is when inflation-prone countries would gain from tying their hands.

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[1] An alternative would have been to assume that realignments not only compensated for cumulative inflation differentials since the last realignment, but also adjusted for expected future inflation differentials so that the PPP was maintained on average over the duration of each fixed exchange rate. See Giavazzi and Pagano (1985) and Collins (1987b).

[2] McCallumm (1984) discusses and evaluates the links between credibility and disinflation, focusing on the United States.

In fact, there are many reasons to doubt that the simple announcement of joining the EMS has been viewed by either Monetary Authorities or domestic residents as tying the hands of the Central Bank. I have already mentioned that virtually no evidence of monetary or inflation convergence emerged during 1979-82. Sachs and Wyplosz (1986) show that "stock prices, capital outflows and the forward discount" during parts of 1981, 1982 and early 1983 "all point to a significant worsening in confidence" (p. 294) in French macroeconomic and exchange rate policy. Expectations of disinflation emerged, not when France joined the EMS in 1979, but after domestic policies turned sharply restrictive in 1982-83. Many authors have discussed also the role of capital controls in enabling France (and Italy) to conduct independent monetary policies.[3] It is not at all clear what role the EMS played in the reversal. In particular, if France had opted for austerity, and had stuck to a consistent program of restraints, the disinflation may well have occurred even if France had still belonged to the Snake.

This paper applies work on international policy coordination to the EMS to ask whether joining the EMS should have helped to reduce inflation rates after the second oil shock.[4] Other papers which study policy coordination in the EMS include Canzoneri and Gray (1985), Melitz (1985), Oudiz (1985), Giavazzi and Giovannini (1986b), Canzoneri and Henderson (1987) and Roubini

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[3] Giavazzi and Pagano (1985) provide one discussion of capital controls.

[4] Useful references to the policy coordination literature include Buiter and Marston (1985), Canzoneri and Henderson (1987) and Fischer (1987).

(1987) and are discussed further in Section II.

This approach does allow us to ask whether, ceteris parabus, joining the EMS is likely to reduce inflation. It is also useful because it focuses on how the rules defining the interaction between countries affect the outcomes.

Three interrelated issues are involved: the impact on expectations and on wage setting behavior, the affect on Central Bank resolve and/or objectives and the implications of "changing the rules of the game". While it is possible to subsume all three under "changing the rules of the game" and to derive the implications theoretically, I believe that the issues are separate in the real world, and that it is useful to distinguish among them. As discussed above, joining the EMS need not have tied the hands of the French Central Bank, and need not have influenced expectations about future prices and exchange rates. However, the EMS is an unusual multilateral exchange arrangement with different "rules" than alternative exchange arrangements.

Section II of this paper applies the international policy coordination approach to the EMS under alternative interaction rules. It has two objectives. The first is to examine the implications of alternate exchange regimes (including cooperative and noncooperative) on average inflation and on the divergence of inflation rates under the assumption that wage formation and exchange rate expectations are unaffected. If being in the EMS has no affect on Central Bank credibility, what affect will it have on inflation? The second is to compare the inflationary implications of shifts in expectations under the alternative exchange rate regimes. If a Central Bank manages to convince domestic residents that it will carry through a disinflation, does it matter what the exchange regime is?

To anticipate one of the punchlines from the theoretical analysis, how inflation within the EMS differs from inflation in a nonEMS regime depends critically on how the EMS exchange regime is specified. This point is also stressed by Canzoneri and Henderson (1987), however, they use a different framework, and do not attempt to separate the effects of different rules from the effects of a change in credibility.

In fact, there is widespread disagreement about how to model the System. (The various approaches are discussed in Section II.) The paper shows that, depending on one's view, one could expect that the EMS regime would either raise or lower the mean and variance of inflation among members. Thus, theoretical analysis alone can not support or refute the EMS-Inflation Hypothesis. Many of the questions are empirical ones.

There is relatively little empirical analysis of the impact of the EMS on inflation. While a detailed empirical analysis is not the focus of this paper, it is informative to explore some of the evidence. Proponents of the Hypothesis often point to empirical findings in Ungerer et. al. (1986). Their paper estimates inflation equations across a large sample of industrial countries from 1974 to 1984, and finds that the coefficient on an EMS "dummy" variable is consistently negative and significant. However, in addition to some econometric problems, there are alternative explanations for their findings. In particular, many nonEMS countries also underwent deflations after 1979.

The paper is composed of three remaining sections. Section II develops a theoretical model, and identifies a number of ways to specify the EMS exchange regime. It then examines the inflationary implications of various regimes. Section III reviews and extends the empirical evidence. The final

section provides a summary and discussion of the EMS-Inflation Hypothesis in light of the theoretical and empirical findings.

II. A Theoretical Framework

This section theoretically examines the implications of different exchange regimes for the mean and the variance of intra-EMS inflation. To highlight the view that the announcement of a change in government policy is not enough to change perceptions about the future, I choose a version of the two country Mundell Flemming model in which expectations are backward -looking. Oudiz (1985) uses a similar framework to simulate the welfare gains under alternative regimes for EMS countries.

It is important to note that the framework considers deflation from an initial inflationary position - a realistic depiction of the post 1979 oil shock situation. It does not analyse inflation arising from a game played by labor unions and policy makers, which is the approach taken by Giavazzi and Giovannini (1986b) and Canzoneri and Henderson (1987) among others.

A. A Simple Model

There are two countries, called France and Germany (denoted by *). They produce aggregate outputs, y and y^*, at prices p and p^*. The nominal exchange rate, e, is the price of deutschemarks in terms of francs. All variables (with the exception of interest rates) are measured in logs and output is measured as deviations from full employment. The subscript $_t$ will denote time.

Output is demand determined, as described by equations (1a) and (1b). Demand increases as a result of a real depreciation, a rise in foreign output

or a decline in real interest rates.

$$(1a) \qquad y_t = a \cdot s_t + b \cdot y_t^* - cr_t$$

$$(1b) \qquad y_t^* = -a \cdot s_t + b \cdot y_t - cr_t^*$$

where $s_t \equiv e_t + p_t^* - p_t$ is the real exchange rate, $r_t \equiv i_t - p_{t+1}^e + p_t$ and $r_t^* \equiv i_t^* - p_{t+1}^{*e} + p_t^*$ are real interest rates. The superscript ^{e} denotes the expectation at time t.

Capital is assumed to be freely mobile[5] (equation 2). Equation (3) describes real exchange rate expectations as static, but allows for a shift, u. This specification captures the idea that different regimes need not alter market beliefs about the future, but allows for changes in perceptions independent of the regime. The assumption also simplifies the analysis because it implies that the problem for policy makers is time separable. Equations (2) and (3) imply that real interest rates differ only by u.

$$(2) \quad i_t - i_t^* = e_{t+1}^e - e_t$$

$$(3) \quad e_{t+1}^e + p_{t+1}^{*e} - p_{t+1}^e = e_t + p_t^* - p_t + u$$

$$(4) \quad r_t = r_t^* + u$$

For most of the discussion, u will be assumed equal to zero. The consequences of a nonzero u are examined at the end of the section.

The evolution of domestic prices is given by (5a) and (5b). It depends

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[5] Roubini (1987) simulates the effects of capital controls in an EMS without realignment.

on lagged (CPI) inflation and deviations from full employment output.[6] Consumer prices, ρ and ρ^*, are a weighted average of prices in each country (equation 6a and 6b) and inflation is $\pi_t = \rho_t - \rho_{t-1}$.

$$(5a) \qquad p_t - p_{t-1} = \pi_{t-1} + \gamma y_t$$

$$(5b) \qquad p^*_t - p^*_{t-1} = \pi^*_{t-1} + \gamma y^*_t$$

$$(6a) \qquad \rho_t = \lambda p_t + (1-\lambda)(e_t + p^*_t) = p_t + (1-\lambda)s_t$$

$$(6b) \qquad \rho^*_t = \lambda p^*_t + (1-\lambda)(p_t - e_t) = p^*_t - (1-\lambda)s_t$$

Equations (7a) and (7b) relate real balances to income in each country.

$$(7a) \qquad m_t - p_t = y_t \qquad (7b) \qquad m^*_t - p^*_t = y^*_t$$

Substituting from (5) into (7), it is clear that authorities in each country can directly control their own output level through monetary policy. To simplify the notation, output is taken as the instrument of the monetary authorities.

Finally, French and German authorities wish to minimize a loss function

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[6] Equation (5) can be derived under the assumptions that the price of domestic output is a mark-up over wages ($w_t = p_t$) and that wage inflation depends on lagged CPI inflation and current output ($w_{t+1} = w_t + \pi_t + \gamma y_{t+1}$). The same specification is assumed in Germany.

that is quadratic in inflation and output.[7] As already mentioned, it is not necessary to consider the entire intertemporal problem, because utility is separable over time periods. The remainder of the section will drop the time subscripts, except where it is confusing to do so.

$$(8a) \qquad L = (y^2 + \phi\pi^2)/2 \qquad (8b) \qquad L^* = (y^{*2} + \phi\pi^{*2})/2$$

To solve the model, each country's inflation must be solved for in terms of outputs. This is easily done in two steps. First, equations (1) and (4) give the following expressions for real exchange rates and real interest rates:

$$(9) \qquad s = \left(\frac{1+b}{2a}\right)(y - y^*) + \frac{c}{2a}u$$

$$(10a) \qquad r = -\left(\frac{1-b}{2c}\right)(y + y^*) + \frac{1}{2}u$$

$$(10b) \qquad r^* = -\left(\frac{1-b}{2c}\right)(y + y^*) - \frac{1}{2}u$$

As usual, the real exchange rate depends on differences in the policies of the two countries, while the real interest rates depend on combined policies.

The second step is to solve for inflation using equations (5), (6) and (9). Notice that changes in expectations formation (u) are equivalent to shifts in the predetermined portion of inflation (π_0). France is assumed to

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[7] Oudiz (1985) estimates a higher weight on inflation in Germany's objective function than for any of the other EMS countries. Incorporating this asymmetry would provide an additional channel for inflationary bias in France.

have a higher base inflation rate than Germany $\pi_0 > \pi_0^*$. So far, this is the first assymmetry between the two countries.

(11a) $\pi = \pi_0 + \gamma y + \alpha(y-y^*)$

(11b) $\pi^* = \pi_0^* + \gamma y^* - \alpha(y-y^*)$

where $\pi_0 = \pi_{t-1} + (1-\lambda)(s_{t-1} + cu/2a)$, $\pi_0 > \pi_0^*$

$\pi_0^* = \pi_{t-1}^* - (1-\lambda)(s_{t-1} + cu^*/2a)$ and $\alpha = (1-\lambda)(1+b)/2a$

Our primary interest is in the average inflation rate and in the divergence between the two countries inflation rates. These are simple functions of average outputs and of the divergence between outputs respectively.

(12a) $\pi^a = \pi_0^a + \gamma y^a$ (12b) $\pi^d = \pi_0^d + (\gamma+2a)y^d$

where $x^a = (x+x^*)/2$ and $x^d = (x-x^*)/2$.

We also solve for French output as a function of the nominal exchange rates, which will be useful for examining policy regimes in which the exchange rate, not the money supply, is the policy instrument. Using equations (1), (5) and (10), we get:

(13) $y = \bar{y} + r(e + \kappa)$

where $r = 2a/(1+b+2a\gamma)$

and $\kappa = p_{t-1}^* - p_{t-1} + \pi_{t-1}^* - \pi_{t-1} - cu/2a$

Equation (13) also points out that if France uses monetary policy (sets output) so as to maintain a fixed nominal exchange rate, France must essentially follow German leadership by adjusting domestic policy one-for-one with German policy. In the fixed exchange rate regimes, it is convenient to

assume that the nominal exchange rate is set equal to κ.

B. The EMS: Alternatives

The next step is to specify alternative exchange regimes. Ideally, we would like to compare the EMS to the most likely nonEMS regime. However, not only is it is difficult to identify the latter, there is also considerable disagreement over how to best model the EMS itself. The many views can be grouped according to whether policies are chosen cooperatively or non-cooperatively and whether Germany and other members are treated symmetrically or asymetrically.

Many authors assume both non-cooperative behavior and assymetry by depicting Germany as the "leader". For example, Fischer (1987, p. 41) says that "the EMS can be viewed as an agreement by France and Italy to accept German leadership in monetary policy, imposing constraints on domestic monetary and fiscal policies."

There are two different formulations of German leadership. The first assumes that Germany sets monetary policy while the other members subordinate their monetary (and fiscal) policies to maintain fixed exchange rates.[8] This regime has been used to model the EMS by Canzoneri and Gray (1985) and by Roubini (1987), while Oudiz (1985) uses it to model the Snake. An alternative assumption, adopted by Giavazzi and Giovannini (1986), is that

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[8] For simplicity, I model the EMS as establishing fixed exchange rates among members between realignments. This is potentially problematic for Italy, which maintains bands of +/- 6.0%.

Germany sets its monetary policy while the other members set their exchange rates relative to the deutschemark. One obvious problem with the first approach is that it rules out the possibility of exchange rate adjustments through realignment. On the other hand, the second probably goes too far in allowing exchange rate adjustment each "period". (The appropriateness of the alternative approaches is discussed further below.)

Canzoneri and Henderson (1987) discuss both cases. They point out that it makes a difference which approach is taken. The first is a game in which both countries select quantities (of money), while the second is a game in which one player (Germany) selects a quantity while the other selects a price (the exchange rate). It is a well known result from game theory that, in most cases, the outcome of a game depends on whether the instruments are prices or quantities.

Melitz (1985) takes the opposite tack. He assumes that EMS policy making is cooperative and treats the members symmetrically. Roubini (1987) and Oudiz (1985) both condsider cooperation as one of many alternative views of the EMS.

Finally, countries may act symmetrically, but noncooperatively. If both policy makers use monetary policy as an instrument, and set their own policy under the assumption that the other country's instrument is given, this scenario is the familiar Cournot-Nash game which is often used as a benchmark against which to compare the EMS.

Thus, a total of five alternatives will be considered. Three are noncooperative and assume that each policy maker sets its own instrument to minimize domestic loss, taking the other country's policy as given. In the remaining two, policies are set cooperatively based on an equally weighted

function of losses in the two countries. In each case, policy makers are assumed to expect that real exchange rate expectations are static (u=0).

To facilitate the comparisons, outcomes under each regime are depicted graphically. From Equation (12), it is clear that, given π_0 and π_0^*, y^a and y^d determine average inflation and the inflation differential. The expressions for y^a,y^d π^a and π^d in each of the five regimes are given in Tables 1 and 2. These variables are the focus of the regime comparisons.

1.Cournot-Nash (C) Policy makers in each country choose output to minimize losses, as shown in (14).

$$(14a) \quad \min_{y} \; (y^2 + \phi\pi^2)/2 \qquad (14b) \quad \min_{y^*} \; (y^{*2} + \phi\pi^{*2})/2$$

$$\pi = \pi_0 + \gamma y + \alpha(y-y^*) \qquad \pi^* = \pi_0^* + \gamma y^* - \alpha(y-y^*)$$

The first order conditions imply the following reaction functions:

$$(15a) \quad y = \Delta_N (\alpha y^* - \pi_0) \qquad (15b) \quad y^* = \Delta_N (\alpha y - \pi_0^*)$$

$$\Delta_N = \phi(\gamma+\alpha)/[1+\phi(\gamma+\alpha)^2]$$

The equilibrium is shown in Figure 1, at point C. The French and German reaction functions are labeled NN and N^*N^* respectively. The bliss points are denoted by B and B^*. The result is a familiar one. The countries engage in a competitive deflation. France, the country which inherited a higher inflation rate, persues the more restrictive policy: $y<y^*$ and $y^d<0$ (Table 1). The French real exchange rate appreciates (see equation 9), and as shown in Table 2, there is some convergence in inflation rates ($\pi^d < \pi_0^d$).

2.German-Leadership (G) Germany sets output (monetary policy) independently while France maintains a fixed nominal exchange rate. German authorities minimize (16) while France simply follows, setting $y=y^*$.

$$(16) \quad \min_{y^*} \; (y^{*2} + \phi\pi^{*2})/2$$
$$\pi^* = \pi_0^* + \gamma y^* - \alpha(y-y^*)$$
$$y = y^*$$

The first order conditions imply the following solution:

$$(17) \qquad y^* = -\Delta_G \pi_0^* = y \quad , \qquad \Delta_G = \phi\gamma/[1+\phi\gamma^2]$$

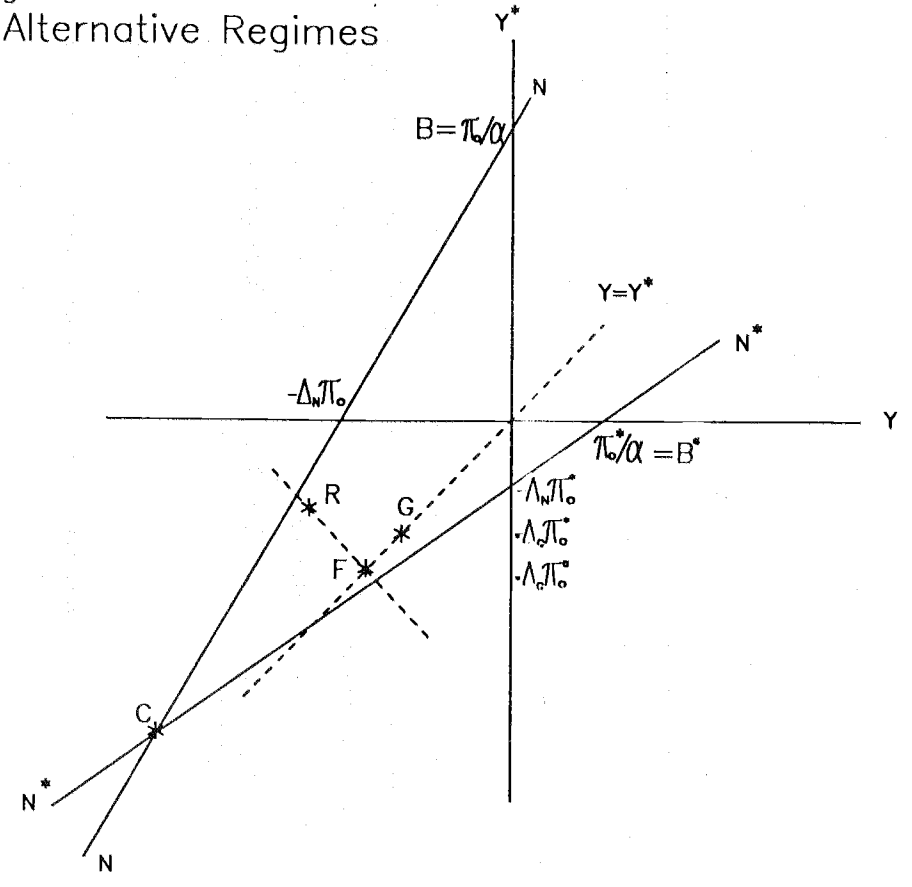
Graphically, Germany chooses the point along $y=y^*$ which gives highest German utility. This is denoted by point G in Figure 1.

Because Germany knows that France will follow its policy lead, there is no competitive deflation. Policies are less restrictive in both countries that in the Cournot Nash equilibrium discussed above. Average inflation is higher than in the Nash outcome, and there is no move towards convergence: $\pi^d = \pi_0^d$ (Tables 1 and 2).

3. Cooperation with Fixed Exchange Rates (F): France and Germany set outputs cooperatively and maintain a fixed exchange rate. Thus, a common policy is chosen to minimize the (equally weighted) loss function in (18).

$$(18) \qquad \min_{y,\, y^*} \; (y^2 + \phi\pi^2)/2 + (y^{*2} + \phi\pi^{*2})/2$$
$$\pi = \pi_0 + \gamma y + \alpha(y-y^*)$$
$$\pi^* = \pi_0^* + \gamma y^* - \alpha(y-y^*)$$
$$y = y^*$$

Figure 1:
Policy Under Alternative Regimes



The first order conditions imply:

$$(19) \qquad y = -\Delta_g \pi_0^a = y^*$$

The outcome (denoted by F in Figure 1) is more deflationary than the noncooperative German leadership with fixed exchange rates because it takes into account France's higher base inflation (Table 2). German welfare is lower than it was at G, but French welfare is higher.

4. Cooperation With Realignment (R) France and Germany set outputs and the nominal exchange rate cooperatively.[9]

$$(20) \qquad \underset{y,\, y^*}{\text{Min}} \quad (y^2 + \phi\pi^2)/2 + (y^{*2} + \phi\pi^{*2})/2$$

$$\pi = \pi_0 + \gamma y + \alpha(y - y^*)$$

$$\pi^* = \pi_0^* + \gamma y^* - \alpha(y - y^*)$$

Noticing that $(y^2+y^{*2})/2 = y^{a2}+y^{d2}$ and that $(\pi^2+\pi^{*2})/2 = \pi^{a2}+\pi^{d2}$, (20) is equivalent to (21). The problem can be separated into selecting average outputs and the divergence between outputs.

$$(21) \qquad \underset{y^a,\, y^d}{\text{Min}} \quad (y^{a2} + \phi\pi^{a2})/2 + (y^{d2} + \phi\pi^{d2})/2$$

$$\pi^a = \pi_0^a + \gamma y^a$$

$$\pi^d = \pi_0^d + (\gamma + 2\alpha) y^d$$

Roubini (1987) points out that whether or not countries sterilize intervention in foreign exchange markets determines whether a cooperative system in name operates symmetrically in practive.

In the solution (Tables 1 and 2), average inflation is the same in the two cooperative regimes. The only difference is that when realignment is allowed, the high inflation country (France) will follow more deflationary policy, and will experience a real appreciation. Table 1 also shows that output divergence, y^d is larger under the cooperative regime with realignment than it was in the noncooperative Nash. Therefore, there is greater convergence of inflation rates.

Graphically, the outcome is denoted by R in Figure 1. It is along the constant average inflation line that passes through G. The larger output divergence relative to Cournot-Nash implies that the ray from R to the origin is flatter than the ray from C to the origin, as drawn.

5.Money-Exchange-Rate (M) The final regime is the most complex. Germany sets output (monetary policy) taking the nominal exchange rate as given while France controls the exchange rate, taking German output as given.

(22a) $\underset{e}{\text{Min}} \; (y^2 + \phi\pi^2)/2$

$\pi = \pi_0 + \gamma y + \alpha(y-y^*)$

$y = \tau(e + \kappa) + y'$

(22b) $\underset{y^*}{\text{Min}} \; (y^{*2} + \phi\pi^{*2})/2$

$\pi^* = \pi_0^* + \gamma y^* - \alpha(y-y^*)$

$y = \tau(e + \kappa) + y''$

To simplify notation, we take $x \equiv \tau(e+\kappa)$ as the French policy instrument. As shown in (23a), the first order condition for France parallels the one from the Nash game. Even though the policy instrument has changed, France would like the same change in domestic output in response to changes in foreign output as in the Nash game.

(23a) $y = x + y^* = \Delta_N (\alpha y^* - \pi_0)$

(23a') $x = -\Delta_N \pi_0 + (\gamma\Delta_N - 1) y^*$

Equation 23a' gives the French reaction function. An appreciation partially offsets the German expansion so that France responds to a German expansion with a smaller domestic expansion.

Solving the German first order conditions, we get Germany's reaction function in (24). Notice that, given the nominal exchange rate, Germany expects French output to move one-for-one with its own. Not surprisingly, the German reaction here parallels the German Leadership game.

(24) $y^* = -\Delta_G (\pi_0^* - \alpha x)$

To facilitate comparison of the outcome under this regime with the outcomes under the other four regimes, we focus on the equilibrium values of y and y^*. As before, the averages and divergences of output and inflation are given in Tables 1 and 2.

It is also useful to depict the outcomes graphically. Figure 2 shows the equilibria for the four regimes discussed above together with the equilibrium from the money-exchange regime. Equation 11a shows the value of y that will result from the French selection of x given each y^*. As noted above, this relationship is simply NN.

Equation (24) shows the y^* Germany will select given x. The relationship between y^* and the implied value of y is given by (25). The tradeoff for Germany is flatter than it was in the Cournot Nash

game.[10] Taking x as given, Germany now expects y to move one-for-one with y^*. Therefore, y^* is less responsive to different values of y than if Germany policy makers took y as given.

$$(25) \qquad y^* = \Delta_M (\alpha y - \pi_0^*) \qquad , \Delta_M \equiv \phi\gamma/[1+\phi\gamma(\gamma+\alpha)] < \Delta_N$$

Equation (25) is shown as M^*M^* in figure 2. It crosses N^*N^* at $y^* = 0$. It also passes through the point GL. The equilibrium for the money exchange regime is denoted by M.

Although less deflationary than the Nash, this regime is more deflationary than any of the other formulations of the EMS. This can be shown by noting from Table 2 that average output under the M, C, F and R regimes can be rewritten as:

$$(26) \qquad \begin{aligned} &\text{M:} && y^a = -\omega_1\pi_0 - \omega_2\pi_0^* \\ &\text{C:} && y_a = -\omega_N \pi_0^a \\ &\text{F and R:} && y_a = -\omega_G \pi_0^a \end{aligned}$$

where ω_i, i=1,2,N,G are defined in Table 1 and $\pi_0 > \pi_0^*$.

It is straightforward to show that $\omega_G < \omega_1 < \omega_2 < \omega_N$, so that C is the most deflationary, followed by M and then by the two cooperative regimes. The intuition is that France engages in the same competitive deflation here as in the Nash game. But because Germany expects y and y^* to move together, policy

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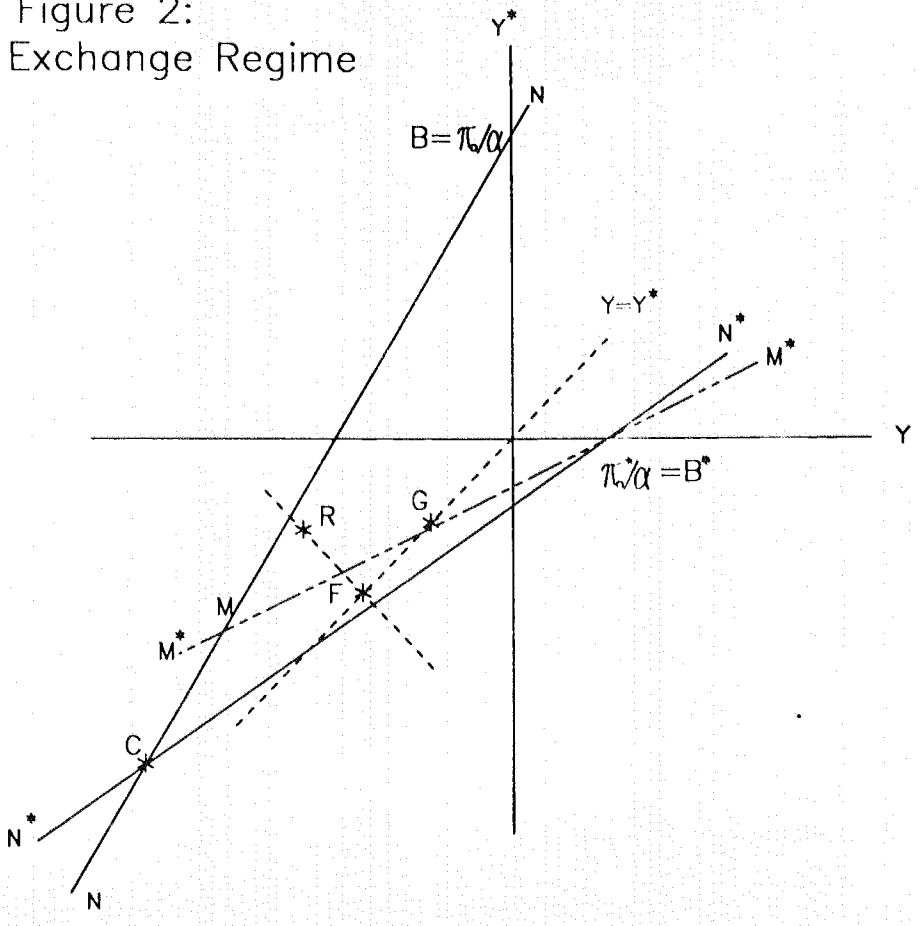
[10] Canzoneri and Henderson (1987) provide additional discussion of the choice of policy instrument and reaction functions in the EMS.

Figure 2:
The Money Exchange Regime



makers engage in less competitive deflation.

Figure 2 also shows clearly that the two types of "German-Leadership" are very different. If leadership means that high inflation EMS members must use their policies to peg the exchange rate (G), the outcome is less deflationary than a cooperative policy would be. The opposite is true if German leadership means that Germany sets monetary policy independently, and the other members select the exchange rate (M).

A final issue is the extent of policy divergence. While it is clear that there is more output divergence (and therefore inflation convergence) in the M than in the C regime, the comparison between the M and R regimes is ambiguous. Manipulating the expressions for π^d in Table 2, it is possible to show that policies diverge more in the R than in the M regime as long as α is not too small relative to γ.[11] The smaller α, the less sensitive domestic inflation rates are to foreign output, and the smaller the scope for EMS members to manage policy differentials cooperatively so as to foster inflation convergence.

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[11] The algebraic condition is quite complex. A sufficient (but not necessary condition) for greater inflation convergence with cooperative realignment than with the money-exchange regime is that $\alpha > \gamma/2$.

Table 1: Policy Under Alternative Regimes

Regime	Average (y^a)	Divergence (y^d)
Noncooperative		
Cournot-Nash	$-\frac{\phi(\gamma+\alpha)}{1+\phi\gamma(\gamma+\alpha)}\pi_0^a$	$-\frac{\phi\alpha(\gamma+\alpha)}{1+\phi(\gamma+\alpha)(\gamma+2\alpha)}\pi_0^d$
German-Leader	$-\frac{\phi\gamma}{1+\phi\gamma^2}\pi_0^*$	0
Money-Exchange	$-\frac{1}{\sigma}\left[\phi\gamma\left[1+\phi(\gamma+\alpha)(\gamma+2\alpha)\right]\pi_0^a+\frac{\alpha}{2}\pi_0^*\right]$	$-\frac{\phi}{\sigma}\left[\gamma(1+\phi\gamma(\gamma+\alpha))\pi_0^d-\frac{\alpha}{2}\pi_0^*\right]$
Cooperative		
Fixed Rates	$-\frac{\phi\gamma}{1+\phi\gamma^2}\pi_0^a$	0
Realignment	$-\frac{\phi\gamma}{1+\phi\gamma^2}\pi_0^a$	$-\frac{\phi(\gamma+2\alpha)}{1+\phi(\gamma+2\alpha)^2}\pi_0^d$

where $\sigma \equiv 1+\phi(\gamma+\alpha)\left[\alpha+2\gamma+\phi\gamma^2(\gamma+2\alpha)\right]$

Table 2: Inflation Under Alternative Regimes

Regime	Average (π^a)	Divergence (π^d)
Noncooperative		
Cournot-Nash	$\frac{\pi_0^a}{1+\phi\gamma(\gamma+\alpha)}$	$\frac{\pi_0^d}{1+\phi(\gamma+\alpha)(\gamma+2\alpha)}$
German-Leader	$\pi_0^a - \left(\frac{\phi\gamma^2}{1+\phi\gamma^2}\right)\pi_0^*$	π_0^d
Money-Exchange	$\frac{1}{\sigma}\left(\left[1+\phi(\gamma^2+\alpha^2+3\gamma\alpha)\right]\pi_0^a - \frac{\alpha\gamma}{2}\pi_0^*\right)$	$\frac{1}{\sigma}\left(\left[1+\phi\alpha(\gamma+2\alpha)\right]\pi_0^d + \frac{\alpha\phi}{2}\pi_0^*\right)$
Cooperative		
Fixed Rates	$\frac{\pi_0^a}{1+\phi\gamma^2}$	π_0^d
Realignment	$\frac{\phi\gamma}{1+\phi\gamma^2}\pi_0^a$	$\frac{\pi_0^d}{1+\phi(\gamma+2\alpha)^2}$

where $\sigma \equiv 1+\phi(\gamma+\alpha)\left(\alpha+2\gamma+\phi\gamma^2(\gamma+2\alpha)\right)$

C. Inflation Under Alternate Regimes

Using Figures 1 and 2, and Tables 1 and 2, it is straightforward to compare the average and the divergence of inflation rates across regimes. The results are summarized below.

Average Inflation (π^a)	Cournot Nash	<	Money-Exchange	<	German Leader	<	Cooperation (Both)
Inflation Divergence (π^d)	Cooperation (Realignment)	<	Cournot Nash	<	Fixed Rates (German Leader and Cooperation)		

As discussed above, the ranking of the money-exchange regime in terms of inflation divergence is ambiguous. There is clearly less divergence than in a Nash game, but there may be either more or less than in the cooperative regime with realignment.

At the beginning of the EMS, all members had relatively high inflation as a result of the 1979 oil price increases. Inflation rates would have fallen under any of the five regimes, however, they would have fallen less under any of the four approaches to modeling the EMS than under a Cournot Nash game. Of course this very deflationary regime also produces the lowest welfare. Rapid deflation is not an achievement to be proud of here.

The second point is that inflationary behavior in the EMS depends on how the system is formulated. The analysis above shows that the EMS will be deflationary if exchange rates are fixed, especially when Germany acts as the leader. The EMS is most deflationary if the high inflation countries use exchange rates as instruments while the low inflation ones set monetary policy.

Third, reductions in average inflation need not coincide with convergence

of inflation rates. The most convergence is likely to occur when members cooperatively set both the exchange rate and monetary policies. In general, there is no convergence when the exchange rate is fixed between member countries.

Which of these regimes most accurately describes the EMS? A complete answer is beyond the scope of this paper. Instead, I make two observations. First, some evidence does suggest an assymmetric role for Germany. Giavazzi and Giovannini (1987) and Roubini (1987) argue that Germany has continued to sterilize the impact of foreign exchange interventions on the domestic money supply. As they point out, assymmetric sterilization can turn a system with symmetric rules for intervention into an assymmetric system.

The second is that none of these regimes is likely to do a good job over the entire 1979-1987 period because none of these approaches accurately captures the exchange rate management issue. Exchange rates have remained fixed over long periods of time. Adjustments have come at irregular intervals, and have been of various magnitudes. With only a few adjustments, it is difficult to tell whether or not the timing and magnitude has been a cooperative decision.[12]

One possibility is that Germany acts as the leader between realignments

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[12] Some recent papers apply models with fixed costs to exchange rate adjustment to examine the timing and magnitude of exchange rate adjustments in the EMS. Giavazzi and Pagano (1985) assume that France is a small country which can select the exchange rate. Collins (1987b) assumes that France and Germany act cooperatively.

by setting monetary policy. The extent to which other EMS members must follow depends on the width of their exchange rate band and the importance of capital controls. However, this scenario is still consistent with cooperation - or bargaining - when the exchange rate bands are adjusted.

D. Changes in Expectations

One of the most frequently citied reasons for why the EMS should help to bring down inflation is that it might alter expectations. Our analysis so far has ruled out this channel. In fact, there is little evidence of shifts when the EMS was first instituted. For example, Sachs and Wyplosz (1986) argue that expectations did not change until 1982-3.

We now suppose that after a series of restrictive measures, residents in the high inflation country there is a decline in the inertial part of inflation (π_0 falls). In the current formulation, the shift comes about through an expected real appreciation (a fall in u). Alternatively, the shift could be introduced through the domestic pricing equation (5).

The impact on the average and the divergence of inflation rates can be found by differentiating the expressions in Table 2 with respect to π_0. Since our primary interest is in the relative sizes of the effects, the ranking is shown below.

Impact of a change in π_0 on π :

Cournot Nash	<	Money Exchange	<	Cooperative (Both)	<	German Leader

Impact of a change in π_0 on π^d:

Cooperative (Realign)	?	Money Exchange	<	Cournot Nash	<	Cooperative, (Fixed)	German Leader

Although the Cournot-Nash regime was the most deflationary, a fall in the inertial French inflation has the smallest effect on average inflation of EMS members because both will engage in less competitive deflation. In fact, the largest payoffs, in terms of lower average inflation, come in the German leadership regime. Since policy depends only on inertial inflation in Germany, there is no offsetting change in equilibrium policies.

Similarly, the fall in π_0 has the largest effect on inflation differentials under the two fixed exchange rate regimes. As discussed above, the ranking of the Cooperative-Realignment and the Money-Exchange regimes is ambiguous. In both of these regimes, a reduction in the initial inflation differential will result in an offsetting reduction in the extent to which policies contribute towards inflation convergence.

This discussion provides one explanation for the original doubts but recent popularity of the EMS-Inflation Hypothesis. During the first few years of the EMS, there was little empirical evidence supporting the view that joining had fostered convergence. It was not until perceptions of government policies changed some years later that observers noted the rapid deflation and attributed it to the EMS.

III. Empirical Evidence

This section assesses some empirical evidence for the inflation convergence hypothesis. The results are not conclusive. They should be viewed as a first step to a detailed analysis of the data, which is beyond the scope of this paper. It is useful to begin with an overview of the inflation experiences for EMS and non-EMS countries. I consider seven EMS countries and fifteen non-EMS countries from 1974 to 1986.[13]

A. Overview of the Inflation Experience

Table 3 shows the mean and standard deviation inflation rates for the two country groups over different time periods. As shown, the group of non-EMS countries had larger average and more variable inflation rates than the EMS countries both before the EMS (1974-78) and after the EMS (1979-86) was instituted. The table also shows that, while the average inflation rates declined in both country groups between 1974-78 and 1979-86, the decline was larger within the EMS (22%) than outside the EMS (14%). Furthermore, the standard deviation of inflation rates increased only marginally within the EMS but increased substantially outside of the System. These facts provide some support for the EMS-Inflation Hypothesis.

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[13] The EMS countries are Belgium, Denmark, France, Germany, Ireland, Italy and the Netherlands. The nonEMS countries are Australia, Austria, Canada, Finland, Greece, Iceland, Japan, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland the United Kingdom and the United States.

Table 3 -Inflation Rates

	1974-78	1979-86	1979-82	1983-86
EMS				
average	10.52	8.18	10.93	5.43
std. dev.	5.11	5.22	5.25	3.51
Non-EMS				
average	14.20	12.26	14.31	10.21
std. dev.	9.19	12.10	11.32	12.59

However, the Table shows no evidence of any average reduction or convergence of inflation among EMS members during the first three years (1979-82). These indicators rose in the years following the second oil shock for both country groups.

It is also important to point out that the comparisons are sensitive to which countries are included in the nonEMS group. The broad sample included in Table 3 provides the 'best case' for the Hypothesis. EMS members would more closely ressemble a comparator group which excluded Portugal, Spain and especially Iceland. (Inflation in Iceland ranged from 22% to 86% during 1974-86.)

B. Results From Panel Data

A second approach is to econometrically examine the differences between the two country groups using pooled cross-section, time series data. This is the approach followed by Ungerer et al. (1986). They conclude that the EMS did help to reduce inflation because they find a significant and negative coefficient on an EMS dummy variable. Their conclusions are explored below.

For each country, real money demand is assumed to be an increasing

function of real income, and a decreasing function of expected inflation. As shown in Equation (27), a simple log linear structure is assumed.

$$(27) \qquad \log(M)-\log(P) = \beta_0 + \beta_1 \log(Y) - \beta_2 \pi^e$$

Expressing the relationship in terms of growth rates and solving for inflation gives Equation (28).

$$(28) \qquad \pi = \hat{m} - \beta_1 \hat{y} + \beta_2(\pi^e - \pi^e_{t-1})$$

A variety of options are available at this point. Following Ungerer et. al. we assume that the slope coefficients are identical across countries and estimate equations using the pooled data set. They substitute the actual change in inflation for the difference in expected inflation rates, and include a dummy variable (EMS) which is one for EMS members after 1979 and zero otherwise. We begin with this approach, and then include additional dummy variables, and consider an alternative proxy for expected inflation.

The first column from Table 4 reports the results following the approach in Ungerer et. al.[14] As shown, the EMS shift term is negative, although not significant. The magnitude implies that, other things equal, inflation in EMS members was 0.9% smaller during the EMS period than either before 1979 or for nonEMS members.

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[14] The results in Table 2 differ from those reported in Ungerer because of differences in the time period and in the group of nonEMS countries. Ungerer reports statistically significant EMS shift parameters. The study also presents estimates using alternative measures of inflation and money growth.

Table 4: OLS Results

Dependent Variable: Inflation (π_t)

	1	2	3[1]	4	5[1]
Constant	0.055	0.064	0.085	0.064	0.081
	(0.006)	(0.008)	(0.007)	(0.009)	(0.007)
$\hat{M}$	0.514	0.514	0.238	0.484	0.202
	(0.033)	(0.033)	(0.040)	(0.036)	(0.040)
$\hat{Y}$	-.074	-.083	-.030	-.076	0.011
	(0.082)	(0.082)	(0.065)	(0.091)	(0.067)
$(\pi_t - \pi_{t-1})$	0.691	0.684	0.651		
	(0.079)	(0.078)	(0.087)		
$(\pi_{t-1} - \pi_{t-2})$				0.407	0.606
				(0.086)	(0.088)
EMS (74-78)		-.022	-.010	-.022	-.008
		(0.011)	(0.008)	(0.012)	(0.008)
EMS (79-85)	-.009	-.007	-.001	-.008	-.002
	(0.008)	(0.009)	(0.007)	(0.010)	(0.007)
1979-85		-.011	-.016	-.008	-.008
		(0.008)	(0.006)	(0.009)	(0.006)
$R\text{-Bar}^2$	0.552	0.556	0.280	0.447	0.278
Std. Error	0.483	0.480	0.420	0.527	0.361
# Obs.	252	252	240	252	240

(Standard Errors in Parentheses.)

[1] Excluding Iceland

However, there are many possible explanations for this finding. In particular, all countries may have experienced shifts in the behavior of inflation after 1979. Alternatively, the EMS countries could have had lower average inflation before the EMS was instituted.

The second column of Table 2 presents the results of a regression which includes two additional shift parameters. One allows the EMS period (post 1979) to differ from the pre-EMS period for all countries in the sample. The other allows a separate constant term for the EMS member countries in the pre-EMS period.

As shown in column 2, the additional variables have little affect on the estimated relationships between money and income growth and inflation. But the original EMS shift parameter decreases in magnitude and in significance. The post-1979 dummy and the earlier EMS dummy both have larger negative coefficients. The latter is significantly different from zero. These results provide no support for the EMS-Inflation Hypothesis.

In fact, if Iceland is excluded from the country list, the point comes through even more strongly. These estimates are reported in column 3. First, the fit of this simple regression equation deteriorates significantly. Most of the deterioration can be attributed to the decreased importance of money growth. Second, the post 1979 dummy variable is now strongly significant, while both EMS dummies decline in magnitude and in significance. Whatever shift occurred after 1979, occurred among both EMS and nonEMS countries.

Table 4 does not support the inflation convergence hypothesis. But neither does it refute the hypothesis because the equations are seriously misspecified. Perhaps the most important problem is the usage of the actual

inflation differential as a proxy for expected inflation.[15] Since this variable includes the current inflation rate, it is clearly endogenous. The fourth and fifth columns of Table 4 address this problem by using lagged inflation differentials as a proxy for expectations. Columns 4 and 5 report regressions which include and which exclude Iceland respectively. In both cases, the explanatory power of the estimated equation declines, and the post-1979 dummy becomes less significant.

Thus, there is evidence of a shift in inflation behavior after 1979 among industrialized countries as a whole. There is little or no evidence of any special shifts among EMS members. However, these results should be viewed as suggestive only. They are very sensitive to which countries are included in the sample. (They are also to the period of estimation.) Furthermore, the equations explain only a fraction of the inflationary behavior of these countries. A conclusive analysis will require more carefully specified structures which allow for differences among countries. This is an interesting area for future research.

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[15] Another problem is that the money supplies will be endogenous for countries with fixed exchange rates and that coefficients are likely to differ across countries. There are also difficulties of interpretation if the money demand functions are unstable.

IV Concluding Remarks

Between 1979 and 1986 there was an impressive reduction and convergence of inflation rates among EMS members. However coincidence alone is not enough to determine causality. The fact that little convergence occurred during the first half of the System's existence makes the claims especially suspect.

This paper has argued that changing the policy regime can affect the inflationary outcome in at least two ways. First, it can change market perceptions and increase credibility in a disinflationary program. Second, it alters the rules of the game - the instruments available to policy makers and the tradeoffs they perceive from changing instruments. In the real world, these two need not occur simultaneously. Evidence suggests that they did not, at least for France. While joining the EMS may have altered the rules of the game, it had little initial impact of expectations or on the credibility of the high inflation governments. Changes in credibility, price setting behavior and expectations came a few years later.

The paper developed a theoretical model in which changes in the rules of the game could be distinguished from changes in expecation formation. There are three basic points. First, if expectations are backward-looking, an EMS is likely to be less deflationary than a noncooperative Cournot-Nash alternative. However, more deflation is not necessarily a good thing. In fact, welfare is higher under less deflationary EMS regimes than under the most deflationary noncooperative regime.

Second, it makes a difference how the EMS works. If Germany leads with the other members maintaining fixed exchange rates, then a move to more cooperation would tend to be deflationary. However, if German leadership

implies that the followers select the exchange rate, a more cooperative regime would be more expansionary.

Third, if a change in expectations comes about, perhaps because of persistent and consistent policy makers, average inflation rates will fall more under EMS regimes than under the Cournot-Nash alternative. Again, the particular outcome depends critically on how the EMS functions. This result may help to explain why many observers are now convinced that the EMS itself helped to reduce inflation even though there were few believers until recently.

Finally, simple cross-section time-series analysis does not show evidence of any shift in EMS inflation behavior after 1979. Instead, there is some evidence that all countries underwent a shift after 1979 and that inflation rates were lower and less divergent within EMS countries even before they joined the System.

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