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## The Role of Policymakers' Reputation in the EMS Disinflations: An Empirical Evaluation

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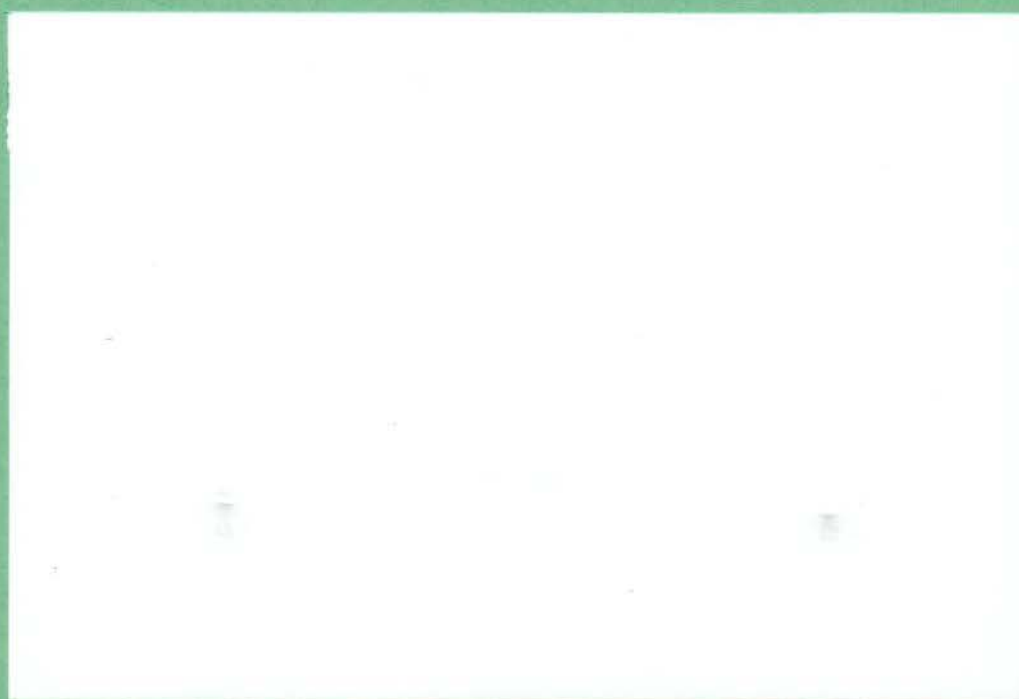
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## The Role of Policymakers' Reputation in the EMS Disinflations: An Empirical Evaluation

by

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### Abstract

It is frequently argued that the EMS itself in connection with the high anti-inflation reputation of the German Bundesbank is responsible for the inflation reduction and convergence which member countries have experienced. Based on the game theoretical model of Backus and Driffill (1985), an empirical measure of the government's reputation for fighting inflation is derived. By using a Bayesian learning approach, time-varying estimates of these counterinflation reputation measures are computed for the original EMS member countries and for a control group of major non-EMS countries. The paper finds that only the smaller EMS participants have gained anti-inflation reputation during the EMS period.

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# THE ROLE OF POLICYMAKERS' REPUTATION IN THE EMS DISINFLATIONS: \* An Empirical Evaluation

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It is frequently argued that the EMS itself in connection with the high anti-inflation reputation of the German Bundesbank is responsible for the inflation reduction and convergence which member countries have experienced. Based on the game theoretical model of Backus and Driffill (1985), an empirical measure of the government's reputation for fighting inflation is derived. By using a Bayesian learning approach, time-varying estimates of these counterinflation reputation measures are computed for the original EMS member countries and for a control group of major non-EMS countries. The paper finds that only the smaller EMS participants have gained anti-inflation reputation during the EMS period.

## 1. Introduction.

Giavazzi and Pagano (1988) formulate the hypothesis that the European Monetary System (EMS) may be viewed as an institutional arrangement which has allowed member countries to 'borrow counterinflation reputation' from the Bundesbank and hence has facilitated disinflations that would not have been possible outside the system. To date there is only limited empirical support for such an 'EMS effect' on inflation rates: Ungerer, Evans and Nyberg (1983, 1986), Rogoff (1985), Artis (1987), Collins (1987) and Weber (1990b) find that inflation rates have not behaved in a fundamentally different way in EMS member than in non-member countries. If anything, De Grauwe (1990) shows that disinflation inside the EMS has been slower than outside the system, which he attributes to the inability of EMS countries to adopt a 'short sharp shock' deflation due to their

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exchange rate constraint. At first sight the existing evidence therefore appears to largely reject the above hypothesis.

The present study focuses exclusively on the reputational aspects of EMS membership, as postulated in Giavazzi and Pagano (1988) and Giavazzi and Spaventa (1989) by drawing on the recent macroeconomic policy-game literature. Whilst being strongly empirically motivated, this analysis of policy credibility has not been seriously taken to the data, as Persson (1988) notes. Following Wyplosz (1989) the existing empirical literature on credibility and reputation may be divided into the two broad categories of direct and indirect evidence.

The *indirect approach* is based on Fellner's (1979) stabilization policy argument that a 'credible policy' is less costly – in terms of output foregone – than a policy which the public expects to be abandoned. Consequently, 'credible policies' imply more favourable output-inflation trade-offs. For EMS member countries this hypothesis is examined in a few papers: Christensen (1987) and Kremers (1990) examine whether suspected deflationary policy shifts in Denmark and Ireland respectively were 'credible' in the sense that actual inflation or interest rates were lower than those predicted from structural Phillips curve models estimated over the period prior to the policy shift. A similar approach is taken in Giavazzi and Giovannini (1989), who use vector autoregressive models of inflation and output growth to search for policy shifts to more credible policies in EMS member countries. Other less formal evidence is provided in Sachs and Wyplosz (1987), Giavazzi and Spaventa (1989) and Dornbusch (1989), who compare estimates of 'sacrifice ratios', defined as the cumulated increase in unemployment rates divided by the total decrease in the rate of inflation, and in De Grauwe (1990), who compares the history of output-inflation trade-offs between countries. The main problem with this *indirect evidence* is that it is very imprecise with respect to how credibility or reputation are to be defined and measured.

More precise concepts are used in the *direct approach* to estimating credibility and reputation by Baxter (1986), Hardouvelis and Barnhart (1989) and Weber (1990a, 1991), who empirically quantify pre-specified measures. Such measures are derived in the policy-game literature: the model of Cukierman and Meltzer (1985a), for instance, relates credibility to the speed by which the public learns about permanent changes in policy. In a subsequent paper Cukierman and Meltzer (1986b) define credibility in terms of the effects of policy announcements on the public's expectations.<sup>1</sup> Furthermore, the concept of reputation is given content in the model of Backus and Driffill (1985). Counterinflation reputation is viewed as the probability that the policymaker in office is a non-inflationary type. Backus and Driffill (1985) assume that an estimate of this probability may be derived and recursively updated by Bayesian probability learning based on observing inflation. The purpose of the present paper is to use a Bayesian learning approach to quantify an empirical counterpart to this reputation measure.

The remainder of the paper is organized as follows: in section 2 the theoretical concept of counterinflation reputation in a stylized version of the Backus and Driffill (1985) model is discussed. In section 3 this concept is slightly modified and generalized in order to be empirically applicable in a meaningful way. The empirical approach to estimating reputation by Bayesian multi-process Kalman filtering is outlined in section 4. The results from applying this procedure to quarterly consumer price data of EMS member countries are then discussed in section 5. A summary of the main findings in section 6 concludes the paper.

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<sup>1</sup>In Weber (1990a, 1991) the relevance of this concept of credibility is evaluated empirically in the context of monetary quantity targeting, interest rate targeting and exchange rate targeting policies in the European Monetary System (EMS).

## 2. The theoretical concept of reputation

In their attempt to explain the apparent inflationary bias of market economies in a natural rate model, Barro and Gordon (1983) show that a low-inflation equilibrium is dynamically inconsistent in the sense of Kydland and Prescott (1977): low-inflation policies are non-credible if the government is known to care about output. However, this knowledge may not be readily available to the public. To account for this, Backus and Driffill (1985) and Barro (1986) extend the work of Barro and Gordon to situations where the public is uncertain about the governments' preferences, in particular, whether or not it cares about output (or unemployment).

A stylized version of the sequential equilibrium model of Backus and Driffill (1985) is described in equations (1) to (6):

$$y_t = y^n + (\mu_t - \mu_t^e), \quad (1)$$

$$W_t^w = \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t [-\mu_t^2/2 + b(y_t - y^n)], \quad (2a) \quad W_t^h = \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t [-\mu_t^2/2], \quad (2b)$$

$$\mu_t^w = b, \quad (3a) \quad \mu_t^h = 0, \quad (3b)$$

$$U_t = -(\mu_t - \mu_t^e)^2, \quad (4)$$

$$\mu_t^e = E\mu_t | \Omega_t = (1 - \psi_t)(1 - \delta_t)b, \text{ with terminal condition } \delta_T = 0, \quad (5)$$

$$\psi_t = \psi_{t-1} / [\psi_{t-1} + (1 - \psi_{t-1})\delta_{t-1}]. \quad (6)$$

Equation (1) states that deviations of output  $y_t$  from its natural rate  $y^n$  are determined in an aggregate supply function by unperceived inflation  $(\mu - \mu^e)$ . Two types of policymakers co-exist. The inflationary central banker's objective function (2a) assumes that he dislikes inflation  $\mu_t$  and likes economic stimulus  $(y_t - y^n)$ , whilst the anti-inflationary policymaker in (2b) has no such ambitious output target. Consequently, in maximizing his payoff function the 'hard-nosed' policymaker will always adopt zero inflation, as indicated in (3b).<sup>2</sup> On the other hand, if the policymaker is known to be the inflationary type, the corresponding

<sup>2</sup>The model may readily be modified so that the minimum obtains an arbitrary value of inflation  $\mu$ . See Barro (1986).

Nash equilibrium in the finite horizon game with a commonly known terminal period  $\tau$  will be the discretionary outcome in (3a) with  $\mu_t=b$  for all  $t$ . Note that in choosing inflation the policymaker takes as given the public's expectations, which in (4) are assumed to be of the least-squares error type.

The interesting point about the Backus and Driffill model is that in general the public will not know with certainty what type of policymaker is in office. Instead, this information has to be inferred from observing inflation. The problem thereby is that zero inflation realizations do not fully reveal whether the policymaker in office is in fact the anti-inflationary type: zero inflation may also be the outcome under an inflationary policymaker who masquerades with probability  $\delta_t$  as the counterinflationary type.<sup>3</sup> Regardless of whether truly anti-inflationary or not, observing zero inflation will in general increase the governments *anti-inflation reputation*  $\psi_t$ , defined as a subjective probability which is assigned by the public.

Aside from giving content to the notion of reputation, Backus and Driffill (1985) also specify how reputation evolves over time: their counterinflation reputation measure  $\psi_t$  is recursively updated by Bayesian probability learning in equation (6). Reputation thereby increases as long as zero inflation is observed,<sup>4</sup> and is completely destroyed by the occurrence of positive inflation  $\mu_t=b$ , which fully reveals the inflationary government. In view of real world inflation experience this would, however, imply that all countries have lacked counterinflation reputation since zero inflation rates have been the exception rather than the rule in recent times. Thus, to provide an empirically meaningful concept of reputation,

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<sup>3</sup>Barro (1986) shows that such strategic behaviour ( $\delta_t > 0$ ) of the inflationary policymaker is less likely to occur the higher his time preference rate  $r$ . Furthermore, the same qualitative conclusion holds the shorter the governments' planning horizon  $\tau$  and the lower its initial counterinflation reputation  $\psi_0$ .

<sup>4</sup>Enhanced reputation reduces inflationary expectations in equation (5), which in turn increases the output gains from a given future unperceived inflationary policy  $\mu_{\tau-j}=b$ . This motivates the inflationary policymakers' cheating behaviour.



different assumptions about the time series properties of the policymakers' trade-off parameter  $b$  and hence of observable inflation rates  $\mu_t=b$  are required.

### 3. An empirically meaningful concept of reputation

One possibility for implementing reputation in an empirically meaningful way would be to follow Barro and Gordon (1983) and to allow the preference parameter  $b$  and hence the inflation rate  $\mu_t$  to be randomly time-varying. It may be assumed that in this case inflation  $\mu_t$  is given by the sum of a fixed controllable component ( $\mu$ ) and a normally distributed random component  $n_t$  with zero mean and constant finite variance  $\sigma_n^2$ . As before the two types of policymakers are still characterized by choosing to set the controllable component of inflation equal to  $\mu^w=b$  and  $\mu^h=0$  respectively. However, depending on the magnitudes of  $\sigma_n^2$  and  $\mu^w$ , a positive inflation realization will now no longer necessarily reveal the type of policymaker and hence may leave reputation intact for a some time.<sup>5</sup> During this period the public will observe inflation in order to infer whether the mean of  $\mu_t$  tends towards zero or towards  $\mu^w=b$ . Thus reputation is destroyed as soon as the mean ( $\bar{\mu}$ ) of  $\mu_t$  deviates significantly from zero, which is the case for  $\bar{\mu}>2\sigma_n$ .

A problem with the above empirical concept of reputation, however, is that, despite allowing for a stochastically varying inflation rate, inflation still is restricted to stationary stochastic fluctuations. This stationarity assumption is in sharp conflict with the evidence that inflation rates frequently exhibit unit roots, as demonstrated for example in Alogoskoufis (1991) by using Dickey-Fuller tests. Thus, in order to make empirically reasonable assumptions, the analysis below follows Cukierman and Meltzer (1985a,b) in allowing the preference parameter  $b_t$  and hence the inflation rate  $\mu_t$  to follow non-stationary time-paths.

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<sup>5</sup>Vickers (1986) states that in such pooling equilibria the public has no basis for updating the reputation measure  $\psi_t$ . Such a constant  $\psi_t$  follows from equation (6) only if the inflationary policymaker is *known* to behave like the anti-inflationary type with probability one ( $\delta_t=1$ ). See also Barro (1986) on this point.

### 3.1. Reputation and inflation

Instead of being a dichotomous (0,b) variable as in Backus and Driffill (1985), inflation is assumed to be determined by an ARIMA time series model which in order to be more general is formulated below in terms of the price level rather than the inflation rate. The observable price level  $P_t$  is assumed to be the sum of a controllable component  $p_t$  determined by the government's monetary policy actions, and a stochastic control error  $v_t$ , which is independently randomly distributed with mean zero and constant finite variance  $\sigma_v^2$ . This is formalized in a linear measurement equation for the unobservable state  $p_t$ :

$$P_t = p_t + v_t, \quad E(v_t)=0, E(v_t v_t')=\sigma_v^2, E(v_t v_{t-j}')=0 \quad \forall j \neq 0. \quad (7a)$$

The dynamics of the policy determined component  $p_t$  of the price level are described by a set of state transition equations:

$$p_t = p_{t-1} + \mu_t + n_t, \quad E(n_t)=0, E(n_t n_t')=\sigma_n^2, E(n_t n_{t-j}')=0 \quad \forall j \neq 0, \quad (7b)$$

$$\mu_t = \mu_{t-1} + d_t + r_t, \quad E(r_t)=0, E(r_t r_t')=\sigma_r^2, E(r_t r_{t-j}')=0 \quad \forall j \neq 0, \quad (7c)$$

$$d_t = d_{t-1} + s_t, \quad E(s_t)=0, E(s_t s_t')=\sigma_s^2, E(s_t s_{t-j}')=0 \quad \forall j \neq 0, \quad (7d)$$

with  $n_t$ ,  $r_t$  and  $s_t$  defined as independently distributed random variables with mean zero and constant finite variances  $\sigma_n^2$ ,  $\sigma_r^2$  and  $\sigma_s^2$  respectively. Thus, inflation  $\mu_t$  is allowed to follow a random walk with a stochastic drift  $d_t$ , which itself may follow a random walk.

In order to derive a measure of reputation  $\psi_t$ , defined as in Backus and Driffill (1985) as the probability of a government being the anti-inflationary type, two alternative models of price level and hence inflation behaviour under an inflationary and an anti-inflationary government have to be specified.

The *anti-inflationary policymaker* is assumed to aim at maintaining some initially low<sup>6</sup> level of inflation, regardless of the output costs. In terms of the above

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<sup>6</sup>In the empirical reputation estimates such low initial inflation rates  $\pi_0$  are ensured by choosing the start of the sample period in the early 1960s.

time series model this implies that the counterinflationary policymaker will attempt to offset any permanent exogenous shocks  $(r_t, s_t)$  to inflation  $\mu_t$ . In this case the dynamic linear model reduces to:

$$P_t = p_t + v_t, \quad E(v_t)=0, E(v_t v_t')=\sigma_v^2, E(v_t v_{t-j}')=0 \quad \forall j \neq 0, \quad (8a)$$

$$p_t = p_{t-1} + \mu_t + n_t, \quad E(n_t)=0, E(n_t n_t')=\sigma_n^2, E(n_t n_{t-j}')=0 \quad \forall j \neq 0, \quad (8b)$$

$$\mu_t = \mu_{t-1} = \mu_0. \quad (8c)$$

Note that this results from equations (7a) to (7d) for  $d_t=d_{t-1}=0$  and  $\sigma_r^2=\sigma_s^2=0$ . In this special case observable inflation will be a stationary stochastic process with a constant low mean ( $\mu_t=\mu_{t-1}=\mu_0$ ) and a finite variance ( $\sigma_n^2+2\sigma_v^2$ ), whilst the observable price level follows an ARIMA(0,1,1) process.

The *inflationary policymaker* on the other hand is assumed to allow or to generate permanent inflation shocks and may even permanently accelerate inflation rates in order to create positive output effects. In this case inflation behaviour is described by the more general dynamic linear model (7a) to (7d) from above. Thus, under the inflationary policymaker inflation is non-stationary and integrated of order two or three, in which case the observable price level follows an ARIMA(0,2,2) or ARIMA(0,3,3) process.

In specifying an *empirically meaningful concept of reputation* it now makes sense to adopt the stringent criterion that a counterinflationary government will attempt to preserve the initially low levels of inflation according to the time series model (8a) to (8c), in which case inflation rates will be stationary. Conversely, the occurrence of repeated permanent shocks to inflation levels  $\mu_t$  or first differences  $d_t$  reveals the inflationary government, under which inflation rates will be non-stationary and hence have no bounds in the long run.

### 3. Borrowing anti-inflation reputation

Assume now that a government in a open economy with flexible exchange rates has been assigned a low counterinflation reputation due to inflationary behaviour in the past. According to Giavazzi and Pagano (1988) and Giavazzi and Spaventa (1989) an institutional reform such as entering a fixed exchange rate system with a low-inflation centre country may help to gain counterinflation reputation. This may be achieved by credibly pegging the exchange rate<sup>7</sup> vis-a-vis the low-inflation centre on the basis of a purchasing power parity (PPP) condition:

$$P_t^* = P_t - \epsilon_t, \quad (9)$$

where  $\epsilon_t$  is the logarithm of the official bilateral nominal exchange rate and  $P_t^*$  is the logarithm of the non-centre country's price level. Under relatively fixed exchange rates (say  $\epsilon_t - \epsilon_{t-1} \approx 0$ ) inflation rates in the non-centre country ( $\mu_t^* \equiv P_t^* - P_{t-1}^*$ ) will now closely resemble inflation rates in the centre country, which follow a stationary stochastic process. In the terminology of Rogoff (1985b) this policy switch is equivalent to appointing a 'conservative' foreign central banker. Consequently, as the public is observing low and stationary inflation rates after the change in the exchange rate regime, it will gradually learn that a policy switch has occurred, lower its inflation expectations and update the probability that the policymaker in office is now the counterinflationary type. Thus, anti-inflation reputation may be gained simply by pegging the exchange rate and 'tying the policymakers' hands on monetary policy', as postulated by Giavazzi and Pagano (1988).

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<sup>7</sup>In Weber (1991) it is shown that such credible exchange rate pegging policies were the exception rather than the rule in the early EMS years, and that recently the system has converged to a more credible peg.

#### 4. Measuring anti-inflation reputation

To obtain an estimate of counterinflation reputation a Bayesian learning algorithm, a variant of the so-called Bayesian multi-process Kalman filter (MPKF) of Harrison and Stevens (1976), is employed. For a more formal description of this method and for references to other applications in economics the discussion in Weber (1988) should be consulted.

The working of the algorithm may best be explained by transforming the above model into its general state-space representation:

$$e_t = z_t' a_t + S v_t, \quad E(v_t) = 0, E(v_t v_t') = \sigma^2 H, E(v_t v_{t-j}') = 0 \quad \forall j \neq 0, \quad (10a)$$

$$a_t = T a_{t-1} + R u_t, \quad E(u_t) = 0, E(u_t u_t') = \sigma^2 Q, E(u_t u_{t-j}') = 0 \quad \forall j \neq 0, \quad (10b)$$

whereby the following specifications apply:

$$S=1, H=h, a_t=[p_t \mu_t d_t], u_t=[n_t r_t s_t], z_t'=[1 \ 0 \ 0], T=R=\begin{bmatrix} 1 & 1 & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix}, Q=\begin{bmatrix} q_1 & 0 & 0 \\ 0 & q_2 & 0 \\ 0 & 0 & q_3 \end{bmatrix}. \quad (11)$$

The multi-process framework now requires the alternative process models to be specified as sub-models of the above general model. In the present context this is done by simply introducing certain zero restrictions for the variance-covariance matrices of the residuals. For example, the reference model for inflation under an anti-inflationary policymaker assumes  $q_2=q_3=0$  and thus only allows for a combination of purely transitory price level shocks (model  $M_t^1$  with  $q_1=q_2=q_3=0$ ) and/or purely transitory inflation shocks (model  $M_t^2$  with  $h=q_2=q_3=0$ ). On the other hand, inflation under an inflationary policymaker may be generated by higher order shocks ( $q_2, q_3 > 0$ ), which may be purely permanent inflation shocks (model  $M_t^3$  with  $h=q_1=q_3=0$ ) and/or purely permanent shocks to the drift in inflation rates (model  $M_t^4$  with  $h=q_1=q_2=0$ ).<sup>8</sup>

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<sup>8</sup>Clearly the latter type of shocks may not be very relevant to most OECD countries. The Bayesian learning of the MPKF then ensures that the probability weight attached to this process model will decline drastically and that it will be almost completely disregarded after some time, as discussed in more detail below.

Given these four alternative specifications of the variance-covariance matrices  $Q^i$  and  $H^i$  ( $i=1,2,3,4$ ), estimates of the unobservable state vectors  $a_t^i$  and their variance-covariance matrices  $\sigma^2\Phi_t^i$  may now be extracted from the observable process  $e_t$  by using the Kalman filter. The possibility of stochastic process switching is explicitly taken into account.

Assume that the observable price level process switches from model  $M_{t-1}^i$  ( $i=1,2,3,4$ ) in period  $t-1$  to model  $M_t^j$  ( $j \neq i$ ) in period  $t$ . Let us denote this process switching model by  $M_{t,t-1}^{ij}$ . The Kalman filter's prediction and update equations may then may be used to forecast price level movements under four types of pure stochastic processes and twelve types of stochastic process switching, given a suitable initialization of the state vector ( $a_{t_0}$ ) and its variance-covariance matrix ( $\sigma^2\Phi_{t_0}$ ):

$$\alpha_{t,t-1}^{ij} = T\alpha_{t-1,t-1}^i, \quad (11a)$$

$$\Phi_{t,t-1}^{ij} = T\Phi_{t-1,t-1}^i T' + RQ^j R', \quad (11b)$$

$$\alpha_{t,t}^{ij} = \alpha_{t,t-1}^{ij} + K_t^{ij} \epsilon_t^{ij}, \quad (11c)$$

$$\Phi_{t,t}^{ij} = (I - K_t^{ij} z_t') \Phi_{t,t-1}^{ij} (I - K_t^{ij} z_t')' + K_t^{ij} H^j K_t^{ij}, \quad (11d)$$

$$\epsilon_t^{ij} = y_t - z_t' \alpha_{t,t-1}^{ij}, \quad (11e)$$

$$K_t^{ij} = \Phi_{t,t-1}^{ij} z_t (F_t^{ij})^{-1}, \quad (11f)$$

$$F_t^{ij} = z_t' \Phi_{t,t-1}^{ij} z_t + S'H^j S. \quad (11g)$$

In order to calculate an overall estimate of the state  $a_{t,t}^i$  and its variance  $\Phi_{t,t}^i$  a probability weighted average of the sixteen individual state and variance estimates  $a_{t,t}^{ij}$  and  $\Phi_{t,t}^{ij}$  is calculated as:

$$\alpha_{t,t}^i = \sum_j \pi_t^{ij} \alpha_{t,t}^{ij} / \pi_t^i, \quad (12a)$$

$$\Phi_{t,t}^i = \sum_j \pi_t^{ij} \{ \Phi_{t,t}^{ij} + [(\alpha_{t,t}^{ij} - \alpha_{t,t}^i)(\alpha_{t,t}^{ij} - \alpha_{t,t}^i)] \} / \pi_t^i, \quad (12b)$$

where  $\pi_t^{ij}$  is the posterior probability of model  $M_t^{ij}$  and  $\pi_t^i = \sum_j \pi_t^{ij}$  holds, as described in more detail below. The inclusion of the term  $[(\alpha_{t,t}^{ij} - \alpha_{t,t}^i)(\alpha_{t,t}^{ij} - \alpha_{t,t}^i)]$  in addition to the individual estimates  $\Phi_{t,t}^{ij}$  in equation (21b) is justified by the fact that a large

dispersion of the point estimates around their average should reduce confidence in the precision of the average point estimate.

The above probability distribution of the alternative process models is calculated and recursively updated in the Bayesian part of the multi-process Kalman filter by using Bayes' law. To illustrate this process, assume that each model  $M_t^i$  at each point in time has a prior probability  $E_{t-1}\pi_t^i$  as well as a posterior probability  $\pi_t^i$ , and that the probability of process switching  $M_{t-1}^{ij}$  is denoted by  $\pi_t^{ij}$ . According to Bayes' theorem the conditional posterior probability  $\pi_t^{ij}$  of each model may then be calculated as:

$$\begin{aligned} \pi_t^{ij} = & \text{PROB} \{ P_t \mid M_t^i, M_{t-1}^i, (P_{t-1}, P_{t-2}, P_{t-3}, \dots) \} \\ & * \text{PROB} \{ M_t^i \mid M_{t-1}^i, (P_{t-1}, P_{t-2}, P_{t-3}, \dots) \} \\ & * \text{PROB} \{ M_{t-1}^i \mid (P_{t-1}, P_{t-2}, P_{t-3}, \dots) \} \\ & / \text{PROB} \{ P_t \mid (P_{t-1}, P_{t-2}, P_{t-3}, \dots) \}, \end{aligned} \quad (13)$$

and can be formalized by using the likelihood function from the Kalman as:

$$\pi_t^{ij} = k_t L_t^{ij} E_{t-1}\pi_t^i \pi_{t-1}^i, \quad (14)$$

with

$$L_t^{ij} = \left[ 2\pi \sigma^2 F_t^{ij} \right]^{-1/2} \exp \left[ -(\epsilon_t^{ij})^2 / 2\sigma^2 F_t^{ij} \right], \quad (15)$$

$$E_{t-1}\pi_t^i = \frac{\theta E_{t-2}\pi_{t-1}^i + \xi_{t-1}^i}{\sum_j (\theta E_{t-2}\pi_{t-1}^j + \xi_{t-1}^j)}, \quad \text{with } \theta=1, \quad (16)$$

$$\pi_{t-1}^i = \sum_j \pi_{t-1}^{ij}, \quad (17)$$

$$\xi_{t-1}^i = \sum_j \pi_{t-1}^{ij}. \quad (18)$$

The transformation of old prior ( $E_{t-2}\pi_{t-1}^i$ ) and posterior ( $\xi_{t-1}^i$ ) probabilities into new prior probabilities ( $E_{t-1}\pi_t^i$ ) for the subsequent period in equation (16) represents the Bayesian learning mechanism, and may be viewed as the empirical counterpart to equation (6).<sup>9</sup> The counterinflation reputation measure  $\psi_t$  thereby

<sup>9</sup>Driffill (1988) states that this MPKF setup closely parallels the Bayesian probability learning used in Backus and Driffill (1985).

is the sum of the two probabilities  $E_{t-1}\pi_t^1$  and  $E_{t-1}\pi_t^2$  of the transitory and permanent inflation shock models:

$$\psi_t = E_{t-1}\pi_t^1 + E_{t-1}\pi_t^2, \quad (18)$$

and is largely determined by the relative forecasting performance of these two models over the recent periods, as measured by their likelihood function (17).

Having outlined the empirical implementation of the counterinflation reputation measure  $\psi_t$ , the empirical results obtained from applying this approach to consumer price data of EMS member countries and to a small control group of non-member countries may now be described.

#### 5. Empirical estimates of counterinflation reputation

The empirical estimates below are based on applying the MPKF to the logarithms of the quarterly consumer price indices for the period 60Q1 to 90Q4. The filter is initialized in 60Q3 by using the actual price level  $P_{t_0-1}$  and inflation rate  $\mu_{t_0-1}$  prior to the estimation period as an estimate of the initial state vector  $a_{t_0}^i$  ( $= [P_{t_0-1} \mu_{t_0-1} 0] \forall i=1,2,3,4$ ). Furthermore the initial prior and posterior probabilities were chosen as  $E_{t_0-1}\pi_{t_0-1}^i = \pi_{t_0-1}^i = 0.1$  for  $i=1,4$  and  $E_{t_0-1}\pi_{t_0-1}^i = \pi_{t_0-1}^i = 0.4$  for  $i=2,3$ , which implies an initial reputation estimate of  $\psi_t = 0.5$ .

The average reputation measures for the period 60Q3–90Q4 are reported in Table 1, together with a test of inflation stationarity and the means and standard deviations of inflation rates, both in the initial EMS member countries and in the remaining G7–countries, which are referred to as a control group.

Table 1 about here
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Four main findings should be mentioned: first, amongst all countries the counterinflation reputation estimate is found to be highest for Germany. This outstanding reputation estimate is consistent with the highly significant Augmented Dickey–Fuller (ADF) test for inflation stationarity and the lowest



inflation mean and standard deviation of all countries. Second, relatively high counterinflation reputation estimates are also found for the Netherlands and Denmark, where inflation rates have also been stationary, as indicated by the highly significant ADF test for a unit root. However, these stationary inflation rates have been higher and more variable than German inflation rates, in particular in Denmark. Thus, when comparing these reputation estimates one should bear in mind that whilst Denmark and the Netherlands have a similar reputation estimate, the underlying tolerated average inflation rate is almost twice as high in Denmark as in the Netherlands. Third, for France and Italy low counterinflation reputation estimates are obtained as a result of their non-stationary inflation rates.<sup>10</sup> The lowest reputation estimate for France is thereby consistent with the lowest ADF test for a unit root. Finally, amongst the non-EMS G7 countries only Japan and to a lesser extent the United Kingdom are found to have relatively high counterinflation reputation estimates, which may be justified by their higher and more variable but also stationary inflation performances.

A more detailed picture of the estimates is revealed by Table 2, which reports period averages of the counterinflation reputation measures for the overall period reported above and for three sub-periods, one of which is the EMS period.

Table 2 about here
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Columns 3 and 4 contain the relevant estimates on which a judgment of the validity of the 'EMS hypothesis' may be based. An important result from Table 2 is that counterinflation reputation outside the EMS has not changed significantly between the pre-EMS and EMS period.<sup>11</sup> The same conclusion holds for the two largest EMS countries, Germany and France, which have preserved their high and

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<sup>10</sup>For such non-stationary series the mean and standard deviation of inflation levels in the last two columns of Table 1 are meaningless and thus have to be disregarded.

<sup>11</sup>This statement holds if the significance of reputation gains and losses is judged on the basis of  $\pm 2$  standard deviations of the reputation measure for the EMS period.

low counterinflation reputations respectively. However, as suggested by the 'borrowing reputation' hypothesis, counterinflation reputation is found to have increased significantly in the Netherlands, Denmark and Ireland, and insignificantly in Belgium.<sup>12</sup> This suggests that especially the smaller EMS member countries have gained reputation under the EMS arrangement. Finally, Table 2 also reveals that counterinflation reputation is found to have declined significantly in Italy.

Figure 1 summarizes these results graphically and indicates the existence of three groups of countries during the EMS period: first, the high counterinflation reputation group is led by Germany, closely followed by the Netherlands, Denmark and Ireland, all of which have gained counterinflation reputation during the EMS period, as indicated by their position above the diagonal. Amongst the non-EMS G7 countries only Japan falls within this group. Second, a group of countries with intermediate counterinflation reputation is formed by Belgium and the non-EMS G7 countries Canada and the United Kingdom. Third, the low counterinflation reputation group consists of France, Italy and the United States.

Figure 1 about here

The evidence reported so far clearly supports the 'borrowing reputation' view of the EMS in two respects: as postulated by Giavazzi and Pagano (1988), Germany is found to be the low-inflation high-reputation centre of the EMS, and has largely managed to maintain this high reputation. Furthermore, the smaller EMS countries have gained counterinflation reputation, but such significant reputation gains are neither outside the system nor for the larger EMS countries, France or Italy. This is hardly surprising since for large economies 'tying the policymakers' hands on monetary policy', as is required by the 'borrowing reputation' hypothesis, is obviously a less attractive policy option. This view is

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<sup>12</sup>This is due to the high variability of the Belgium reputation estimates, as judged on the basis of  $\pm 2$  standard deviations of the reputation measure for the EMS period.

consistent with the fact that both France and Italy have continued to resort to precommitted monetary quantity targeting policies throughout the EMS period.

Given the apparent difference between the counterinflation reputation estimates for the large and small non-German EMS countries, it is interesting to compare how reputation has evolved over time. For this purpose the time-paths of the counterinflation reputation measures are displayed in Figures 2 to 4.

Figure 2 about here

Figure 2 compares the reputation estimates for Germany, France and Italy, and makes the above mentioned grouping of the large EMS countries in 'hard currency' and 'soft currency' countries most obvious. Clearly, German counterinflation reputation is high throughout the sample period, but declines slightly after the end of the EMS deflation period in 1986, as monetary quantity targets were consistently overshoot and a modest reflation emerged. The French reputation for anti-inflation policies is considerably lower than German reputation. The French reputation measure fluctuates around its initial level prior to March 1973, but declines after the occurrence of the first oil price shock and the French withdrawal from the 'snake' in early 1974. It reaches its minimum in mid 1976, and remains relatively low thereafter. Finally, the Italian reputation measure is relatively high in the first half of the sample, declines strongly after the mid-1970s and largely resembles the behaviour of the French reputation measure during the EMS period.

The smaller EMS countries, such as the Netherlands, Belgium, Denmark and Ireland, traditionally place a higher weight on external stability and can therefore be expected to have gained more than the larger countries from the provision of a 'hard currency' standard within the EMS. However, in Weber (1991) it is argued that the EMS must be viewed as a bipolar system which in addition to the 'hard currency' option of pegging to the DM also offered the 'soft currency' alternative of

pegging to the Franc. Depending on this choice, the smaller EMS countries may have borrowed 'good' or 'bad' counterinflation reputation.

The relevance of the above proposition may best be illustrated by referring to Figure 3, which displays the reputation estimates for Belgium and the Netherlands relative to the two large EMS countries Germany and France. For the Bretton Woods period the Dutch counterinflation reputation estimate lies below the German estimate, but increases considerably after the institution of the European currency 'snake' arrangement between Germany, France, the Benelux countries and Denmark in April 1972. Throughout the snake period the Dutch reputation measure moves slightly below the German reputation measure. The onset of the EMS in March 1979 also has little impact on the apparent symmetry between Germany's and Holland's reputation measures. Finally, during the EMS disinflation period (1983-86) the Dutch reputation measure increases slightly and rises above the German reputation estimate after late 1986, which is consistent with the lower inflation rates in the Netherlands relative to Germany during these years. The Belgian reputation measure closely resembles the Dutch reputation measure prior to the first oil price shock of 1973, but declines drastically thereafter and follows the French reputation measure during the pre-EMS period. In the aftermath of the second oil price shock there is a sharp increase in Belgian counterinflation reputation, as inflation rates closely followed those in Germany and the Netherlands during 1979-82, but reputation declines again somewhat thereafter.

Figure 3 about here

The overall impression suggested by Figure 3 is that after maintaining an intermediate position throughout the Bretton Woods period the major gains in Dutch anti-inflation reputation were obtained by committing monetary policy to the 'hard currency' option of pegging the Dutch guilder to the German mark at the onset of the European currency 'snake' in 1972 and by continuing this commitment

under the EMS arrangement after 1979. The Belgian reputation estimate on the other hand seems to switch from a similar intermediate position to closely following the French reputation estimates prior to the EMS, and recently appears again to follow a more intermediate path.

Figure 4 displays the Danish and Irish reputation estimates relative to the German counterinflation reputation measure. Due to the stationarity of Danish and to a lesser extent Irish inflation rates, as revealed by Table 1, both reputation estimates are relatively high throughout the sample. Prior to the first oil price shock Danish 'anti-inflation' reputation fluctuates around a level of 0.8, but declines temporarily in response to the first oil price shock. As in the case of the Netherlands, the main gains in Danish counterinflation reputation relative to the loss of reputation from accommodating the first oil price shock are materialized during the remainder of the 'snake' period, with little additional gains arising during the early EMS period. However, similar to the Netherlands, the Danish reputation measure rises above the German measure towards the end of the EMS disinflation period, when the Danish government enforced legal upper-limits for wage increases in 1985. This belated EMS effect on Danish anti-inflation reputation is consistent with the findings of Artis (1987), who suggests that Denmark appears to have used the EMS initially more as a crawling peg<sup>13</sup> and only later moved to a more strongly counterinflationary stance by pursuing level pegging policies.

Figure 4 about here

The Irish reputation measure in Figure 4 follows a quite different time pattern. After its initial increase the Irish reputation estimate declines continuously between 1964 and 1972. Following a transitory rise in 1973-74, the

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<sup>13</sup>As in Artis (1987) a crawling peg is defined as an exchange rate arrangement in which inflation differentials are not fully accommodated, and realignments are underindexed adjustments.

estimate displays a sharp permanent increase during 1975-76, which is largely due to the substantial cuts in selected VAT rates and certain new subsidies (together equivalent to about 4 percent of the consumer price index) as well as strong external deflationary forces.<sup>14</sup> Reputation then roughly fluctuates around 0.8 between 1977 and 1982, and thereafter stabilizes considerably at a relatively high level. This post 1982 Irish consolidation, which is also reported in Dornbusch (1989), is re-enforced towards the end of the EMS deflation period in 1986. Thus, as in the case of Denmark above, one may argue that the recent increase in Irish counterinflation reputation can be attributed to the Irish policy shift from an accommodating exchange rate policy to a determined effort to reduce inflation, a process in which the EMS clearly became an instrument of deflation.

## 6. Summary and Conclusions

Based on empirical estimates of a pre-specified counterinflation reputation measure, the present study shows that 'borrowing reputation' from the Bundesbank in order to disinflate, as postulated by Giavazzi and Pagano (1988), has only worked for the smaller EMS participants. Three groups of EMS countries have been clearly identified: first, Germany is found to have had extremely high counterinflation reputation both before and during the EMS. In a second group of countries, consisting of the Netherlands, Denmark, Ireland and to a lesser extent Belgium, counterinflation reputation is relatively high and has increased during the EMS period. For Denmark and Ireland these gains in counterinflation reputation were significant and quite substantial. The EMS, and in the case of the Netherlands and Denmark even the pre-EMS 'snake' system, appear to have provided these smaller ERM participants with an institutional framework to 'borrow counterinflation reputation' from the Bundesbank. Third, with respect to

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<sup>14</sup>See OECD Economic Surveys: Ireland, 1975, p. 6

the larger non-German EMS participants, France and Italy, the evidence suggests no apparent gains in counterinflation reputation. However, this result is not too surprising, given the considerable degree of foreign exchange controls and the relatively large and frequent realignments in both countries, which tend to undermine or prevent any potential disciplinary effects of the EMS.

In evaluating the overall evidence provided in this paper, it is worth noting that the reputation estimates presented here are fairly consistent with the 'borrowing reputation' hypothesis, if limited to the smaller EMS countries and including the pre-EMS 'snake' system. In Weber (1991) it is demonstrated that this result must be attributed to the fact that only some of the smaller EMS countries have credibly pegged their exchange rates vis-a-vis the DM, whilst this has not been the case for the large EMS countries. Thus, the inability of the larger EMS countries to 'borrow reputation' from the Bundesbank is due to their unwillingness to 'tie their hands on monetary policy', a necessary pre-requisite of the 'borrowing reputation' hypothesis.

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**Table 1. Average counterinflation reputation estimates, inflation stationarity tests and means and standard deviations of inflation (61Q1–90Q4).**

	reputation		stationarity	inflation performance	
	mean	stdv.	ADF test†	mean	stdv.
Germany	92.3	( 9.4)	3.51***	3.4	2.8
France	38.4	(13.7)	2.18	6.5	4.0
Italy	56.4	(21.1)	2.28	8.9	6.5
Netherlands	84.2	(10.1)	4.33***	4.6	4.4
Belgium	60.8	(20.6)	2.46	4.9	3.4
Denmark	84.1	(11.6)	4.08***	7.1	4.9
Ireland	74.2	(11.4)	2.85*	8.4	8.0
United Kingdom	65.7	(14.6)	3.42**	7.9	6.5
United States	51.3	(26.7)	2.05	5.1	3.5
Canada	54.9	( 8.3)	1.94	5.5	3.5
Japan	77.7	(11.0)	3.15**	5.5	5.6

**Key:** The numbers in parentheses are the standard deviations of the reputation estimates in the sample period 1960Q3–1990Q4.

† Obtained from a regression of the first differences of inflation rates on a constant, two own lags and lagged inflation, with ADF being the t-statistics of the latter regressor. The stars indicate significance of the ADF at 10 (\*), 5 (\*\*), and 1 (\*\*\*) percent critical values, as given in Fuller (1976).

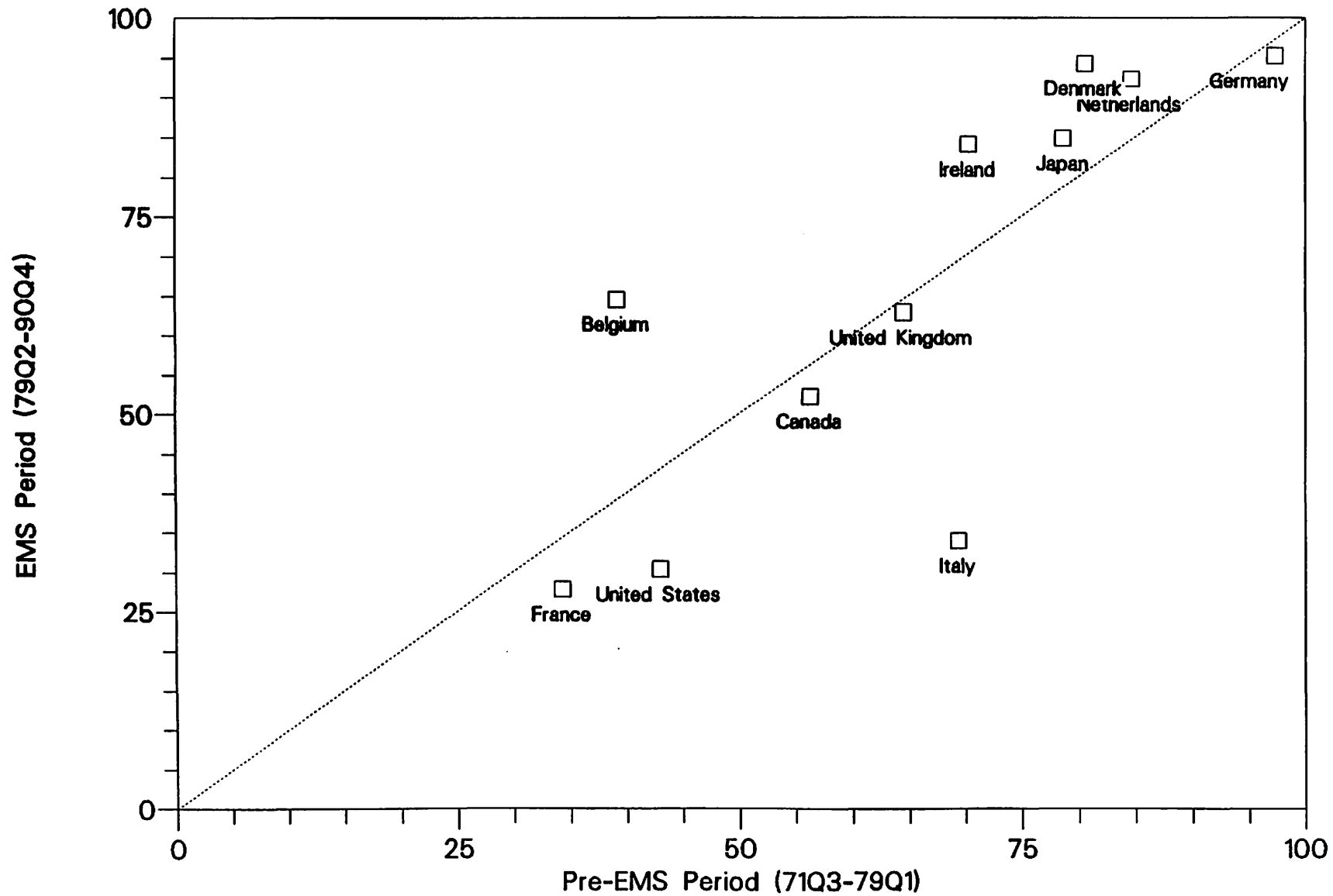
**Table 2. Period Averages of Estimated Counterinflation Reputation Measure**

	60Q3-90Q4	60Q3-71Q2	71Q3-79Q1	79Q2-90Q4
Germany	92.3 ( 9.4)	85.6 (13.2)	97.3 ( 0.6)	95.3 ( 2.0)
France	38.4 (13.7)	53.1 ( 6.9)	33.9 ( 8.9)	27.8 ( 8.1)
Italy	56.4 (21.1)	72.2 ( 8.6)	68.9 (16.3)	34.0 ( 8.2)
Netherlands	84.2 (10.1)	74.6 ( 8.7)	85.2 ( 7.4)	92.3 ( 2.8)
Belgium	60.8 (20.6)	72.4 ( 9.4)	38.3 (20.4)	64.6 (16.8)
Denmark	84.1 (11.6)	75.4 (11.5)	80.5 ( 7.3)	94.3 ( 2.5)
Ireland	74.2 (11.4)	65.8 (10.2)	70.6 ( 9.2)	84.1 ( 3.6)
United Kingdom	65.7 (14.6)	69.9 (10.8)	64.2 (18.6)	62.9 (14.3)
United States	51.3 (26.7)	80.9 (12.6)	41.5 (21.5)	30.3 ( 9.2)
Canada	54.9 ( 8.3)	56.8 ( 7.0)	56.4 ( 8.6)	52.2 ( 8.6)
Japan	77.7 (11.0)	69.5 (11.5)	78.3 ( 8.6)	84.9 ( 5.4)

**Key:** The numbers in parentheses are the standard deviations of the reputation measure in the respective sample periods.

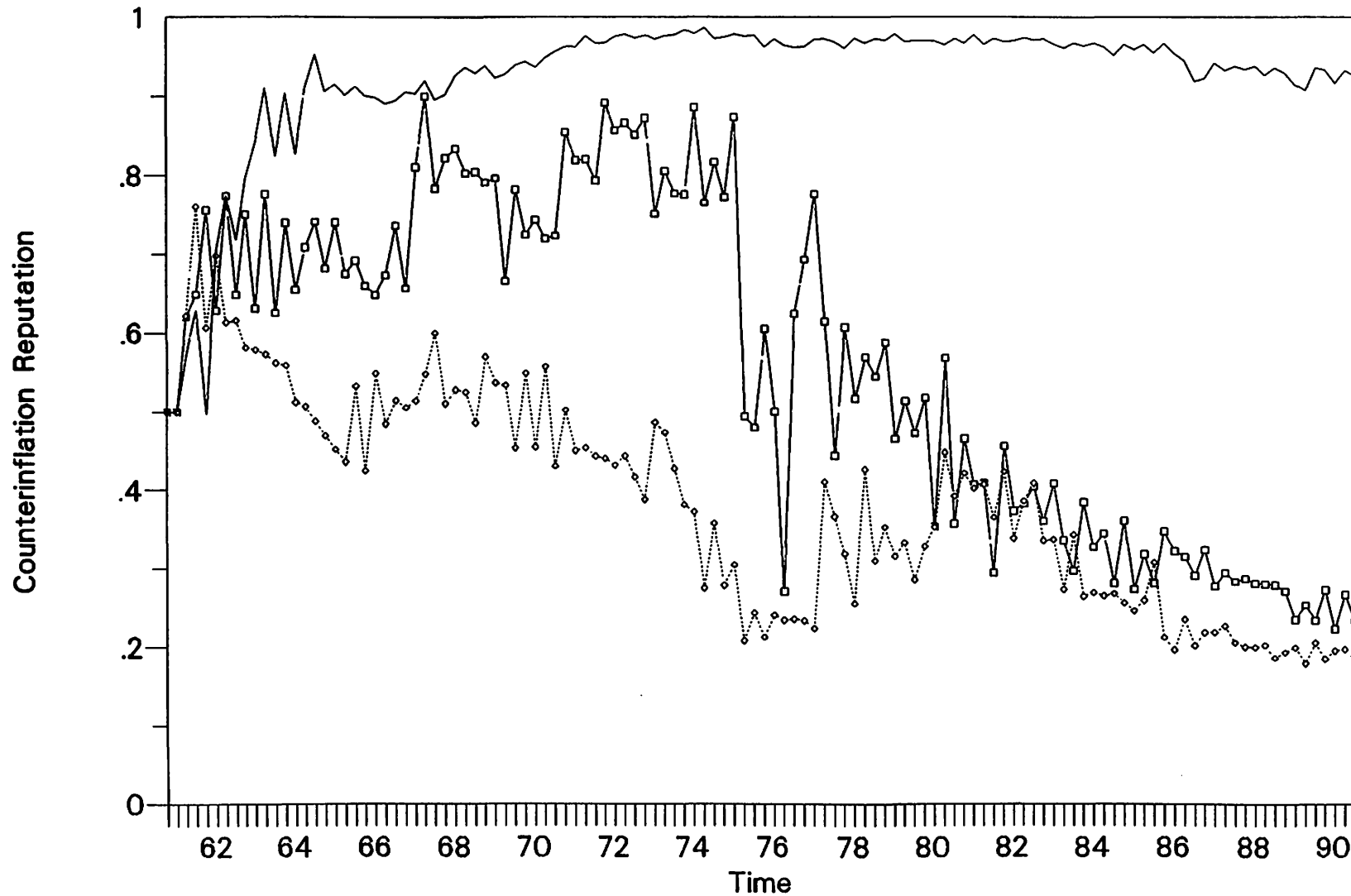
# Figure 1. Average Counterinflation Reputation Measure

Average Prior Probability of Inflation Stationarity (in %)



# Figure 2. Counterinflation Reputation Measure

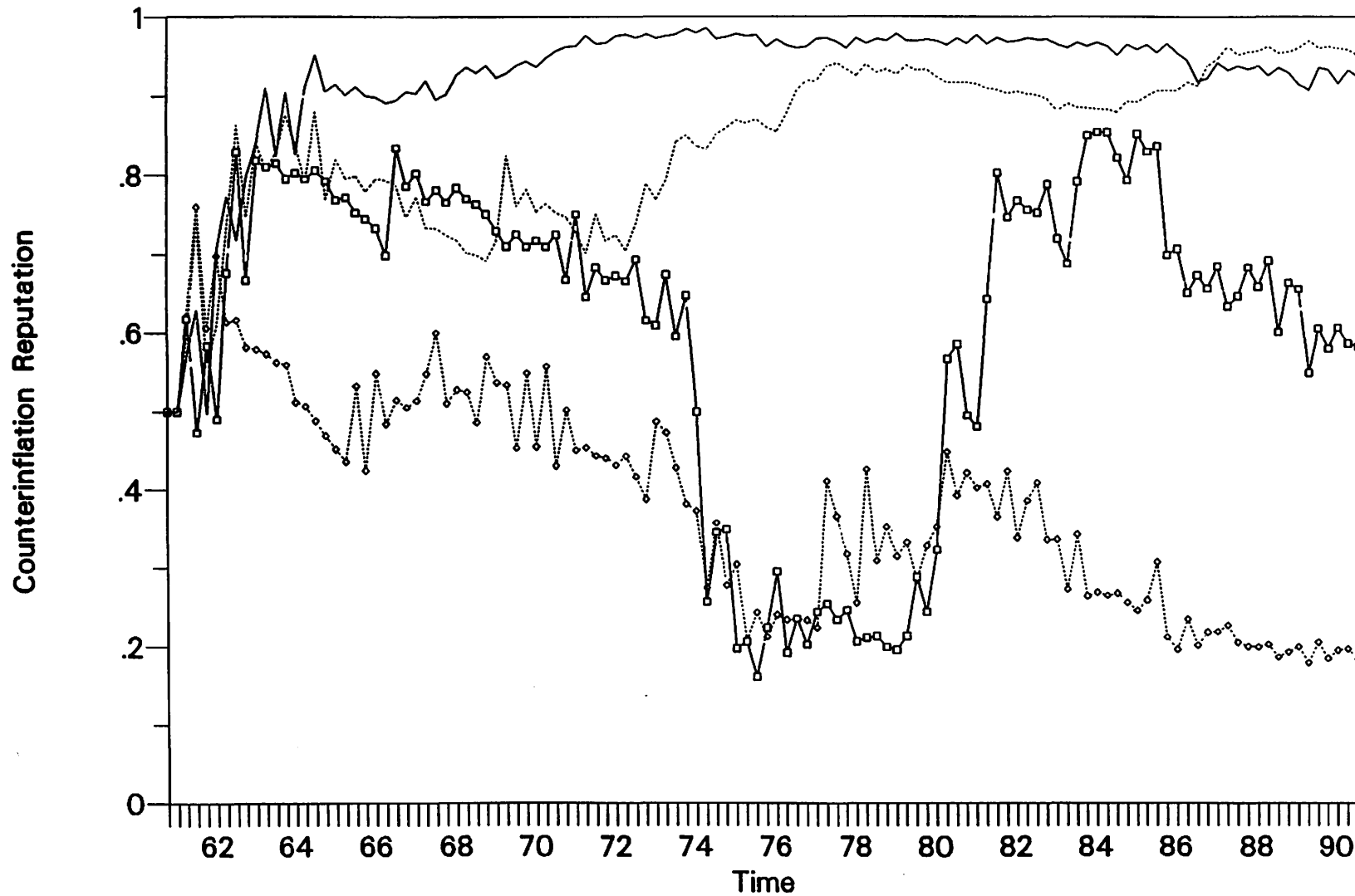
## Prior Probability of Inflation Stationarity



Source: own calculations based on quarterly consumer price data from IMF International Financial Statistics (Germany, Italy) and OECD Main Economic Indicators (France), various issues.

# Figure 3. Counterinflation Reputation Measure

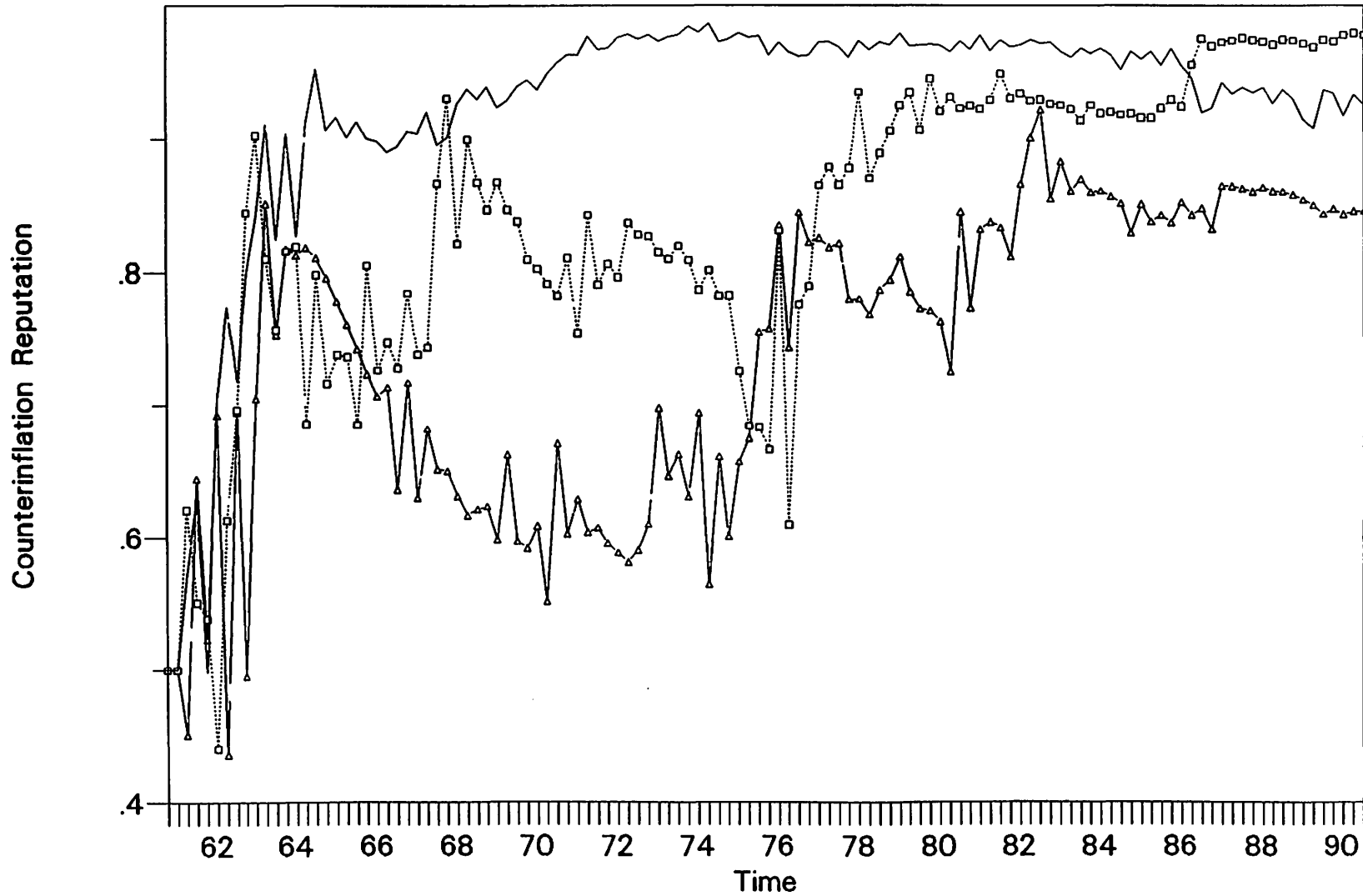
## Prior Probability of Inflation Stationarity



Source: own calculations based on quarterly consumer price data from IMF International Financial Statistics (Germany, Belgium, Netherlands) and OECD Main Economic Indicators (France), various issues.

# Figure 4. Counterinflation Reputation Measure

## Prior Probability of Inflation Stationarity



Source: own calculations based on quarterly consumer price data from IMF International Financial Statistics, various issues.

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