CREDIBILITY AND DISINFLATION IN THE EUROPEAN MONETARY SYSTEM*

Michael Bleaney and Paul Mizen

Analysis of interest differentials in the European Monetary System has suggested a widespread lack of credibility of the Exchange Rate Mechanism in the sense that in most countries the implicit expected rate of devaluation was significant and not far short of inflation differentials vis-à-vis the deutschmark. We present and test a model in which prices reflect expectations of exchange rate behaviour. The results provide mixed evidence that price-setting in countries which participated in the ERM was influenced by the exchange rate discipline.

Up until 1992, the European Monetary System (EMS) was characterised by some degree of convergence of inflation rates, but with higher-inflation currencies partially accommodating excess inflation vis-à-vis the deutschmark by periodic devaluations (Bleaney, 1992). Giavazzi and Pagano (1988) (hereafter GP) hypothesised that the Exchange Rate Mechanism (ERM) functioned as a device whereby the monetary authorities in countries with a low reputation for resisting inflationary pressures could reduce domestic inflationary expectations by fixing their exchange rate to the deutschmark. Such a policy could only be successful if governments were not expected to accommodate excess inflation fully through exchange rate realignments. Evidence from interest rates suggests that this policy was at best only partially successful: there was a significant probability of an accommodating realignment for most ERM currencies over most of the period (Svensson, 1993). Indeed Svensson’s results raise doubts as to whether the ERM had any significant impact on inflationary expectations at all, since his estimated 12-month expected rates of devaluation are not very different from 12-month inflation differentials relative to the mark.

The approach adopted in this paper is to examine price-setting behaviour, since inflationary expectations can affect actual prices, either directly (as in new classical models) or indirectly, by influencing wage contracts which set costs for a significant period of time. If exchange rate realignments were expected to be fully accommodating, the ERM would have no influence on inflationary expectations through the GP mechanism and inflationary expectations would consequently reflect purely domestic factors. If, on the other hand, the ERM did have some influence on inflationary expectations, then expectations of ERM-wide inflation (which we proxy by German inflation) should have had some impact on price-setting in each ERM country. This is the hypothesis which we test, using data from seven countries over the period 1979–90. The sample consists of six ERM countries plus the United

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Kingdom, which functions as a ‘control’ since it did not participate in the ERM in this period.

Previous work on EMS credibility using inflation data encompasses a variety of approaches to the question (see Blackburn et al., 1992; Giavazzi and Giovannini, 1988). Barrell (1990) looked for structural breaks in wage and price equations in France, Germany, Italy and the United Kingdom, but his results did not yield clear evidence of a regime change at the inception of the ERM. Bleaney (1996) examined the relationship between inflation and central bank independence across OECD countries, and tested whether pegging to the DM by EMS and EFTA countries was equivalent to an increase in central bank independence. He assumed that countries acquired the independence of the Bundesbank in proportion to their refusal to accommodate excess inflation (vis-à-vis Germany) through devaluation. His results supported the GP hypothesis. Bini-Smaghi (1994) estimated an inflation regression across 21 OECD countries and found significant negative coefficients for dummies capturing EMS effects. Weber (1992) argued that inflation rates should be stationary only where policy-makers have credibility, and on this basis concluded that only the smaller EMS countries have credibility, and France and Italy do not. This contrasts with the findings of Artis and Nachane (1992), who concluded that the EMS was credible in France, Italy and the Netherlands, but not Belgium. Kremers (1990) showed that for Ireland, whose currency was pegged to sterling before 1979, inflationary expectations were strongly influenced by expectations of inflation in a basket of ERM countries after 1979, whereas previously they had been largely determined by expected UK inflation. Gressani et al. (1988) also found significant EMS effects for Italy, using the Banca d’Italia model. Artis and Ormerod (1996) tested whether the influence of past German inflation on current domestic inflation rates had increased relative to the pre-ERM period (characterised as 1975–82) for France, Belgium and the Netherlands. Unlike most of the other papers their results were negative.

Of all the different approaches discussed above, that of Artis and Nachane is closest in spirit to ours. We test the GP hypothesis by investigating price dynamics in the six countries (other than Germany) which were members of the ERM from its inception, and the United Kingdom, which was not a member until 1990. We estimate a model in which prices are determined by a combination of purely domestic factors and expected German inflation adjusted for expected devaluation. If the ERM has no credibility and the exchange rate policy is anticipated to accommodate any excess inflation, the influence of expected German inflation on domestic price-setting disappears. This model is capable of testing whether the ERM had any credibility in price-setting behaviour, and whether this credibility increased over time. Our initial results from fixed parameter regressions suggest that the ERM had significant credibility in Belgium, the Netherlands and Ireland, through the impact of expected German inflation on domestic inflation, but in France, Italy and Denmark the transmission was found only in price levels, through the real exchange rate. Further investigations using time-varying parameters suggest
that there may be less evidence that credibility has increased for all ERM
countries over time than was first thought. Comparisons with the pre-ERM
period do not suggest significant parameter shifts except for Belgium and
Denmark, and using the time-varying parameters procedure only Italy and
Ireland demonstrated any influence arising from expectations of German
prices, supporting the conclusions of Gressani et al. (1988) and Kremers (1990).
As predicted, there is no evidence that expected German inflation had any
impact on inflation in the United Kingdom.

I. THE MODEL

The model is essentially a modified version of a traditional Lucas supply
function, in which the deviation of output from its equilibrium level is
correlated with unanticipated inflation. In this model, prices in period $t$ are a
function of expected prices based on information at the end of period $t-1$ and
the deviation of output from its natural rate. In the absence of inflationary
inertia, expected prices would simply reflect 'the law of one price’ across
currencies, which in our model means expected German prices translated into
domestic currency at the expected exchange rate. Because of inflationary
inertia (possibly imparted by overlapping contracts), price expectations are a
weighted average of this and an autoregression of past prices. This yields the
following price equation:

$$p_t = \kappa E_{t-1}(\pi_{gt} + \epsilon_t | \Omega_{t-1}) + (1-\kappa)\left(p_{t-1} + \sum_{k=1}^{p} \mu_k \pi_{t-k}\right) + \alpha(y_t - y_t^*),$$  \hspace{1cm} (1)

where $y_t$ is output supply and $y_t^*$ is the equilibrium rate of output; $p_t$ is the
current domestic price level; $\pi_{gt}$ is the current German price level; and
$E_{t-1}(\pi_{gt} + \epsilon_t | \Omega_{t-1})$ is an expectation of the German price level adjusted for the
exchange rate expressed in domestic currency units per deutschmark, given
information set $\Omega$ at time $t-1$ (all variables are in logarithms). Here $\kappa$ captures
the influence of expected German prices on domestic price-setting behaviour.
In (1), it is convenient to write the autoregression of past prices as the price
level in period $t-1$ plus an autoregression of past inflation ($\pi_t$). After
subtracting $p_{t-1}$ from both sides and rearranging, this becomes

$$\pi_t = \kappa E_{t-1}(\pi_{gt} + \Delta \epsilon_t | \Omega_{t-1}) + (1-\kappa)\sum_{k=1}^{p} \mu_k \pi_{t-k}
+ \alpha(y_t - y_t^*) - \kappa(p_{t-1} - \pi_{gt-1} - \epsilon_{t-1}).$$ \hspace{1cm} (2)

Equation (2) expresses inflation as a function of the deviation of output from
equilibrium, expected German inflation, expected exchange-rate changes, past
domestic inflation and the lagged real exchange rate.

We assume that the equilibrium rate of output can be represented as a
weighted average of the previous actual level of output and the previous
equilibrium rate i.e.

$$y_t^* = \delta y_{t-1} + (1-\delta) y_{t-1}^* \quad \text{where} \quad 0 < \delta \leq 1.$$ \hspace{1cm} (3)
This gives an approximation for the equilibrium rate of output in terms of actual output as

$$y_t^* = \sum_{i=0}^{n} \delta(1-\delta)^i y_{t-i-1} = y_{t-1} - \sum_{t=1}^{n} (1-\delta)^i \Delta y_{t-i}. \quad \text{(4)}$$

Agents have to form expectations of both German inflation and the probability of devaluation vis-à-vis the DM.\(^1\) We model expected German inflation as the fitted values from a regression as described below. Devaluation expectations obviously depend on the exchange rate regime. In a floating rate system, where real exchange rates appear to follow something close to a random walk (possibly with slow mean reversion), it would be reasonable to assume exchange rate expectations that are consistent with this hypothesis. In the ERM, which is a target zone system with infrequent realignments of the central parity, unconditional exchange rate expectations are likely to have a bimodal distribution, depending on whether or not a realignment occurs. Let the expected devaluation be \(v\), given that a realignment occurs, and zero if a realignment does not occur, and let the probability of a realignment within the period be \(1-\lambda\). Then the unconditional expected exchange rate change is \((1-\lambda)v\). The parameter \(\lambda\), which may be considered a measure of the credibility of the ERM, is the focus of our analysis. We assume that \(v\), the expected devaluation conditional on a realignment occurring, consists of two components: one which insulates the real exchange rate against differential inflation in period \(t\) relative to the deutschmark, and one which reflects the level of the real exchange rate in period \(t-1\). The motivation for the second component is that the higher the observed real exchange rate, the larger the expected devaluation (should it occur). Thus the model embodies the idea that, if there has been a long period of persistent inflation differentials with no realignment, the resulting rise in the real exchange rate will be reflected in a larger expected devaluation, should a realignment occur. Our measure of credibility \(\lambda\), which is based purely on the expected probability of a realignment, is thus insulated from this effect (but we do allow, at a later stage of the empirical analysis, for \(\lambda\) to vary over time). This yields

probability \(\lambda\):

$$E_{t-1}(\Delta e_t | \Omega_{t-1}) = 0,$$

probability \((1-\lambda)\):

$$E_{t-1}(\Delta e_t | \Omega_{t-1}) = v = \sum_{k=1}^{p} \mu_k \pi_{t-k} - E_{t-1}(\pi_{gt} | \Omega_{t-1}) + \sigma(p_{t-1} - p_{gt-1} - e_{t-1}).$$

The first two terms in the expression for \(v\) ensure that a realignment accommodates any excess inflation relative to Germany in period \(t\); the last term reflects the impact of the level of the real exchange rate on the expected

\(^1\) In what follows expectations are linear despite the prominence of some theoretical models in the target zone and fundamentalist/charalist traditions which support a non-linear relationship (see references in Svensson (1993) and Bleaney and Mizen (1996)).
size of the realignment. The overall probability, taking expectations, is therefore

\[ E_{t-1}(\Delta \epsilon_t | \Omega_{t-1}) = (1 - \lambda) \sum_{k=1}^{p} \mu_k \pi_{t-k} - (1 - \lambda) E_{t-1}(\pi_{gt} | \Omega_{t-1}) \]

\[ + (1 - \lambda) \sigma (p_{t-1} - p_{gt-1} - \epsilon_{t-1}) \]  

By substitution of (4) and (5) into (1) we obtain the expression:

\[ \pi_t = \alpha \sum_{i=0}^{n} (1 - \delta)^i \Delta y_{t-i} + \kappa \lambda \sum_{k=1}^{p} \mu_k \pi_{t-k} \]

\[ - [\kappa - (1 - \lambda) \sigma] (p_{t-1} - p_{gt-1} - \epsilon_{t-1}) \]  

The functional form gives us a testable model which can be used to test the degree of influence of German inflation on domestic inflationary determination in other EU countries. We can write the reduced form equation as

\[ \pi_t = \xi + \gamma_0 \Delta y_t + \sum_{i=1}^{n} \gamma_i \Delta y_{t-i} + \phi_0 E_{t-1}(\pi_{gt} | \Omega_{t-1}) + \sum_{k=1}^{p} \phi_k \pi_{t-k} \]

\[ + \psi (p_{t-1} - p_{gt-1} - \epsilon_{t-1}) + \epsilon_t \]  

In all equations we expect

\[ \gamma_0 = \hat{\epsilon} > 0, \]

\[ \gamma_i = (1 - \delta)^i \geq 0 \quad \text{for} \quad i = 1, 2, 3 \ldots \]  

If the existing ERM target zone for the exchange rate has credibility, then we expect \( \lambda > 0 \), which implies a coefficient on expected German inflation which is significantly greater than zero:

\[ \hat{\phi}_0 = \kappa \lambda > 0. \]  

If, on the other hand, the target zone has no credibility and the exchange rate policy is fully accommodating, then we would expect this coefficient to be insignificant:

\[ \hat{\phi}_0 = 0. \]  

Finally, note that the real exchange rate has conflicting effects. For a given expected rate of devaluation, a higher exchange rate means lower inflation; but it also implies a larger realignment, should one occur, and so implies higher inflation for a given probability of realignment.

In the empirical section equation (7) is estimated by regressing \( \pi_t \) on lagged values of itself, current and lagged values of output, current oil price changes, the lagged real exchange rate and expected German inflation. Expected German inflation is modelled using the fitted values of German inflation generated by estimating the relationship between current German inflation and its own lagged values, lagged values of German oil price inflation and lagged values of German output.

This raises the issue of the treatment of generated regressors in the reduced form model of domestic price setting behaviour. Since domestic residents’
expectations of German inflation are generated from another model, it is possible that including the expectations as a regressor could lead to incorrect conclusions concerning the true impact of German price setting on the rest of Europe. Oxley and McAleer (1993) show that whilst estimates of coefficients on generated regressors are consistent, ‘the conventionally programmed OLS estimates of the covariance matrix…tend to understate the true covariance matrix’ (p. 19) and may cause incorrect inferences to be drawn from diagnostic statistics such as t- and F-statistics, which will tend to be overstated. Along with several other authors (see Wallis, 1980 and Wickens, 1982), they suggest that instrumenting out the generated regressor is a means of avoiding the problem.

In the next section we deal with this issue by checking our OLS estimates against IV results to allow for any potential bias in the t- and F-statistics.

If there is a significant ERM effect on inflation expectations in the member countries, it should be reflected in a shift in the estimated relationship after the inception of the ERM (Artis and Ormerod, 1996). It is possible to test for changes in the slope parameters in our model but several problems make it difficult to determine when the slopes could reasonably be expected to change. First, the period of floating exchange rates before the ERM was short and was characterised by attempts to regulate the exchange rate adjustments between some of the countries (known as the Snake). As a result of the short sample and the fact that the change in regime may not have been very great for many of the countries it may be difficult to detect a significant change in the slope parameters after 1979. Secondly, the ERM did not really exert any influence on exchange rates, and hence could not really be expected to influence price setting, until after 1983, when realignments became markedly less frequent. Influence on the slope parameters may not be evident until 1983 at the earliest and even then it may be a gradual change which occurred. Nevertheless, using data from the pre-ERM period, we tested for shifts in the coefficient of expected German inflation both at the inception of the ERM and at the beginning of 1983.

To account for the fact that credibility gains from the ERM may have been gradual, we analyse the model on the assumption that the coefficients are no longer constant throughout the sample, by introducing time-varying parameters into the model. The parameters on expected German inflation, lagged domestic inflation and the intercept are permitted to vary over the sample according to the following time-varying parameter model:

\[
π_t = \xi_t + \gamma_0 \Delta y_t + \sum_{i=1}^{n} \gamma_i \Delta y_{t-i} + \phi_{it} π_{gt} + \sum_{k=1}^{p} \phi_{it-k} π_{t-k} + \psi(ρ_{t-1} - \rho_{gt-1} - ε_{t-1}) + ε_t
\]

\[
ξ_t = ξ_{t-1} + ω_t
\]

\[
φ_{it} = φ_{it-1} + υ_{it}
\]

for \(i = 0, 1, 2, 3, \ldots\), where

\[ε_t \sim N(0, σ_ε), \quad υ_{it} \sim N(0, σ_{υ})\]

Using (11) as the measurement equation and (12) and (13) as the transition
equations, the model is ideally suited for investigating any gradual evolution of behaviour which results from the institutional changes that have taken place in the operation of the EMS. Equations (12) and (13) assume that the intercept and slope parameter on expected German price inflation are described by a stochastic trend.

It is necessary to specify the form of the time-varying parameters, and we assume that the evolution of each of the variables can be described by a random walk.\(^2\) The random walk specification has the advantage that, since it is non-stationary, it can pick up permanent shifts in credibility, which seems more appropriate in this case. Since the estimates of the time-varying parameters are random walks they are not restricted to lie within a given range. In the case of the time-varying parameter on expected German prices, this is at variance with the assumptions of the model since it is theoretically determined by the product of two variables which lie on the range \([0, 1]\) and should, therefore, lie on \([0, 1]\) itself. Masson (1995) and Hamilton (1990) describe a model which can restrict the time-varying parameters to the range \([0, 1]\) but their model assumes two alternative regimes, to which probabilities are ascribed at each moment, and is not appropriate in a context of the relatively uniform regime of the ERM. The objection that the parameter values are not restricted to lie within \([0, 1]\) only becomes valid if the actual values lie outside the range but our results show that whilst the values of the time-varying parameters do occasionally become negative they are not significantly different from zero. The second reason for allowing the parameters to follow a random walk is that whilst we might wish to restrict the time-varying parameter on expected German inflation to lie within the \([0, 1]\) range we would not want to restrict the other parameters. With these cautionary notes we use the results of time-varying parameter estimates to investigate the evolution of credibility in the ERM.

II. DATA AND ESTIMATION

The reduced-form equations were estimated using quarterly data over the period 1979:1–1990:2 for Germany, Italy, France, Belgium, the Netherlands, Eire, Denmark and the United Kingdom. The choice of the sample end-point was dictated by the reunification of Germany, due to the consequent turbulence in German inflation behaviour thereafter, and also by the fact that the United Kingdom entered the ERM in 1990:3. Data were collected from OECD and IMF sources: income was measured by seasonally adjusted GDP and the price level by its deflator.\(^4\) Oil prices (included in the regression to capture exogenous shocks) were represented by the domestic price of Saudi Arabian light oil. The

\(^2\) The alternative would have been an autoregressive process around a constant mean, but a random walk has certain advantages which we explain in the text.

\(^4\) We realise that there is considerable debate on the most suitable price index/deflator and have devoted some space to the discussion ourselves elsewhere (Bleaney and Mizen, 1995). Our preference for using the GDP deflator reflects the fact that, whilst the viability of real exchange rate stationarity may depend on using prices of goods which are traded internationally, the influence of expectations of German price-setting behaviour on domestic markets does not. Price setting in non-traded goods is still influenced by the price-setting behaviour in Germany so long as non-traded and traded goods are competing in domestic markets.
inflation rate was created from the quarterly differences of the logarithm of the price deflator.\footnote{We choose to use the GDP deflator as our measure of prices because of the sensitivity of the consumer price index to indirect tax changes. An alternative possibility would have been to use producer prices, although the definition of this series tends to vary from country to country.} All variables used in the estimated regressions were stationary according to ADF and Phillips Z(\alpha) tests (i.e. they were stationary after first differencing).

The series for expected German inflation used in the regressions was generated from the fitted values from a regression on itself, output and oil prices from quarters \(t-1\) to \(t-4\). Table 1 shows the results of estimating (7) by

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Table 1

<table>
<thead>
<tr>
<th>Sample</th>
<th>United Kingdom</th>
<th>Italy</th>
<th>France</th>
<th>Belgium</th>
<th>Netherlands</th>
<th>Eire</th>
<th>Denmark</th>
</tr>
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<tbody>
<tr>
<td>1979:1-1990:1</td>
<td>0.005</td>
<td>0.143</td>
<td>0.028</td>
<td>0.021</td>
<td>0.004</td>
<td>0.002</td>
<td>0.034</td>
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<td>(4.022)</td>
<td>(4.361)</td>
<td>(1.139)</td>
<td>(1.335)</td>
<td>(0.449)</td>
<td>(4.086)</td>
<td></td>
</tr>
<tr>
<td>(\Delta p_t)</td>
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<td>-0.007</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(2.081)</td>
<td>(0.540)</td>
<td>(2.956)</td>
<td>-</td>
<td>-</td>
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<td>-</td>
<td></td>
</tr>
<tr>
<td>(\Delta p_{t-2})</td>
<td>0.070</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>(3.082)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>(\Delta p_{t-3})</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>(2.716)</td>
<td>-</td>
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</tr>
<tr>
<td>(\Delta p_{t-4})</td>
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<td>-</td>
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<tr>
<td>(\Delta p_t)</td>
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<tr>
<td>(1.378)</td>
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<td>(\Delta p_{t-2})</td>
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<td>(0.962)</td>
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<td>(\Delta p_{t-3}(\text{fitted}))</td>
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<td>(-0.150)</td>
<td>(2.118)</td>
<td>(1.053)</td>
<td>(2.480)</td>
<td>(2.526)</td>
<td>(2.057)</td>
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<tr>
<td>(\rho-\beta_{0}\rho_{t-3})</td>
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<td>-0.020</td>
<td>-0.019</td>
<td>-0.006</td>
<td>0.007</td>
<td>0.003</td>
<td>-0.033</td>
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<tr>
<td>(-0.339)</td>
<td>(-4.934)</td>
<td>(-4.219)</td>
<td>(-1.124)</td>
<td>(1.479)</td>
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<tr>
<td>(R^2)</td>
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<td>0.813</td>
<td>0.873</td>
<td>0.869</td>
<td>0.603</td>
<td>0.666</td>
<td>0.577</td>
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<td>SEE</td>
<td>0.000</td>
<td>0.000</td>
<td>0.004</td>
<td>0.004</td>
<td>0.005</td>
<td>0.011</td>
<td>0.007</td>
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<td>Serial correlation</td>
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<td>0.733</td>
<td>0.990</td>
<td>0.244</td>
<td>0.738</td>
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<td>1.037</td>
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<tr>
<td>(\sim F(4,35))</td>
<td>[0.361]</td>
<td>[0.361]</td>
<td>[0.435]</td>
<td>[0.977]</td>
<td>[0.537]</td>
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<td>Heteroscedasticity</td>
<td>0.420</td>
<td>3.540</td>
<td>2.390</td>
<td>3.911</td>
<td>1.251</td>
<td>3.330</td>
<td>1.369</td>
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<td>(\sim F(1,38))</td>
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<td>[0.27]</td>
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<td>0.959</td>
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<td>[0.41]</td>
<td>[0.26]</td>
<td>[0.70]</td>
<td>[0.32]</td>
<td>[0.933]</td>
<td>[0.982]</td>
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<td>Banerjee test</td>
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<td>0.275</td>
<td>1.798</td>
<td>1.264</td>
<td>2.180</td>
<td>0.450</td>
<td>19.489</td>
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<tr>
<td>(\sim F(1,36))</td>
<td>[0.59]</td>
<td>[0.900]</td>
<td>[0.099]</td>
<td>[0.099]</td>
<td>[0.099]</td>
<td>[0.099]</td>
<td>[0.099]</td>
</tr>
</tbody>
</table>

Notes: \(\Delta p_{t-1}\) is the ith lag of domestic monthly inflation, \(\Delta p_{t-1}\) is the ith lag of changes of domestic output, the term \(\Delta p_{t-1}\) is the ith lag of oil price inflation measured in domestic currency. \(\Delta p_{t-1}\) is expected German monthly inflation generated using lagged German inflation, lagged changes in German output and lagged oil inflation, s.e.e. is the standard error of the regression. The Serial correlation is tested using a Lagrange multiplier test; Heteroscedasticity is a test for constancy of the variance based on a regression of the squared residuals on the squared fitted values; and Functional form based on Ramsey’s test using the square of the fitted values. The Banerjee test is a test for the significance of the lagged real exchange rate in the dynamic specification. In all cases we use the F version of the test, where available, which is more powerful in small samples than the asymptotically efficient \(\chi^2\) version; \(p\)-values are reported in square brackets.

\(\chi^2\)
ordinary least squares (OLS). The coefficient of expected German inflation is significant at the 5% level for Italy, Belgium, the Netherlands and Eire, but not for the United Kingdom, France and Denmark. Lagged domestic inflation is always significant, suggesting that inflationary inertia is pervasive. Output effects and oil price effects have been retained in the reported results, but the coefficients are never significant (although they are almost always of the expected sign). The lagged real exchange rate is highly significant in the cases of Italy, France and Denmark, but not otherwise, suggesting that German prices have an impact on the price levels rather than inflation in these countries.

Table 2 reports the instrumental variable (IV) estimates of the same equation, with lagged German inflation used as the instrument for expected German inflation, in order to account for the possibility that the use of a generated regressor for expected German prices may lead to incorrect inferences.
on the t- and F-statistics. In this case expected German inflation is significant at the 10\% level in all cases except Italy and the United Kingdom, but at the 5\% level only for the Netherlands and Eire, with France a marginal case. Thus only for the Netherlands and Eire do the IV results unambiguously confirm the OLS results of $\lambda > 0$. On the other hand, for all of the ERM-participating countries the coefficient on expected German inflation is significant at the 10\% level in at least one of the two Tables, whereas for the United Kingdom it is not significant with either OLS or IV estimation.

Tables 3 and 4 are equivalent to Tables 1 and 2, but with the lagged real exchange rate eliminated from the regression where it proved insignificant. The effect, using both OLS and IV estimation, is that expected German inflation is highly significant for Belgium, the Netherlands and Eire, but not for the United Kingdom. Overall, these results suggest some degree of credibility for the ERM, since expected German inflation appears to be significant in price-setting equations for the typical participating country, but not for the United Kingdom, which did not participate.

Instead of comparing coefficients for ERM and non-ERM countries, we might look for shifts that coincide with regime changes. To do this we extended

\begin{table}
\centering
\caption{OLS Estimates Excluding the Lagged Real Exchange Rate}
\begin{tabular}{l|cccc}
\hline
Sample & United Kingdom & Belgium & Netherlands & Eire \\
\hline
\text{Constant} & 0.0003 & 0.0006 & -0.0001 & 0.0002 \\
& (1.067) & (0.371) & (-0.040) & (0.073) \\
\text{$\Delta p_{t-1}$} & 0.324 & - & - & - \\
& (2.286) & & & \\
\text{$\Delta p_{t-2}$} & 0.249 & - & - & 0.280 \\
& (3.366) & & (2.352) & (2.716) \\
\text{$\Delta p_{t-3}$} & - & - & - & 0.379 \\
& & & & (2.716) \\
\text{$\Delta p_{t-4}$} & - & 0.585 & 0.494 & - \\
& & (3.877) & (3.806) & - \\
\text{$\Delta y_t$} & 0.142 & 0.0004 & -0.0002 & - \\
& (1.396) & (0.580) & (-0.160) & - \\
\text{$\Delta y_{t-1}$} & - & - & - & 0.001 \\
& & & & (1.034) \\
\text{$\Delta \lambda^0$} & 0.007 & 0.009 & 0.004 & 0.006 \\
& (1.050) & (3.136) & (1.907) & (0.747) \\
\text{$\Delta \lambda_{fitted}$} & -0.047 & 0.570 & 0.478 & 0.094 \\
& (-0.140) & (4.382) & (2.830) & (2.184) \\
\text{$R^2$} & 0.344 & 0.697 & 0.381 & 0.663 \\
\text{s.e.e.} & 0.009 & 0.004 & 0.005 & 0.011 \\
\text{Serial correlation} & 0.448 & 0.454 & 0.525 & 1.354 \\
\sim F(4,35) & [0.77] & [0.75] & [0.72] & [0.27] \\
\text{Heteroscedasticity} & 0.367 & 0.393 & 0.991 & 8.408 \\
\sim F(1,38) & [0.61] & [0.66] & [0.32] & [0.01] \\
\text{Functional form} & 0.264 & 0.696 & 0.293 & 1.410 \\
\sim F(1,43) & [0.35] & [0.41] & [0.50] & [0.24] \\
\hline
\end{tabular}
\begin{flushleft}
Notes: See Table 1.
\end{flushleft}
\end{table}
the data series for the ERM countries back to 1974, and allowed the coefficients of the inflation variables to vary across the regimes. In Table 5 we report the results of this test. If the shift is assumed to occur at the inception of the ERM, then it always takes the form of an increase in the weight attached to expected German inflation (with the exception of Ireland, where the change is very small), but this increase is not generally statistically significant. If the early

Table 4

IV Estimates Excluding the Lagged Real Exchange Rate

<table>
<thead>
<tr>
<th>Sample 1979:1–1990:1</th>
<th>United Kingdom</th>
<th>Belgium</th>
<th>Netherlands</th>
<th>Eire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.003</td>
<td>0.0002</td>
<td>−0.002</td>
<td>−0.003</td>
</tr>
<tr>
<td>Δφt-1</td>
<td>(0.973)</td>
<td>(0.170)</td>
<td>(−1.334)</td>
<td>(−0.486)</td>
</tr>
<tr>
<td>Δφt-2</td>
<td>0.475</td>
<td>−0.226</td>
<td>(1.265)</td>
<td>0.190</td>
</tr>
<tr>
<td>Δφt-3</td>
<td>−0.133</td>
<td>0.0005</td>
<td>−0.001</td>
<td>0.039</td>
</tr>
<tr>
<td>Δφt-4</td>
<td>−0.546</td>
<td>0.202</td>
<td>−0.002</td>
<td>(1.157)</td>
</tr>
<tr>
<td>Δφt</td>
<td>0.207</td>
<td>0.099</td>
<td>0.006</td>
<td>0.014</td>
</tr>
<tr>
<td>Δφt(fitted)</td>
<td>(−0.64)</td>
<td>(4.964)</td>
<td>(1.920)</td>
<td>(1.425)</td>
</tr>
<tr>
<td>R²</td>
<td>0.342</td>
<td>0.690</td>
<td>0.422</td>
<td>0.494</td>
</tr>
<tr>
<td>s.e.e.</td>
<td>0.009</td>
<td>0.004</td>
<td>0.006</td>
<td>0.013</td>
</tr>
<tr>
<td>Serial correlation</td>
<td>1.761</td>
<td>3.508</td>
<td>4.102</td>
<td>6.119</td>
</tr>
<tr>
<td>~ χ²(4)</td>
<td>[0.77]</td>
<td>[0.48]</td>
<td>[0.39]</td>
<td>[0.19]</td>
</tr>
<tr>
<td>Heteroscedasticity</td>
<td>0.355</td>
<td>0.185</td>
<td>0.006</td>
<td>0.485</td>
</tr>
<tr>
<td>~ χ²(1)</td>
<td>[0.53]</td>
<td>[0.02]</td>
<td>[0.48]</td>
<td>[0.053]</td>
</tr>
<tr>
<td>Functional form</td>
<td>0.356</td>
<td>1.433</td>
<td>3.267</td>
<td>2.976</td>
</tr>
<tr>
<td>~ χ²(1)</td>
<td>[0.53]</td>
<td>[0.23]</td>
<td>[0.07]</td>
<td>[0.09]</td>
</tr>
</tbody>
</table>

Notes: See Table 2.

Table 5

Tests of Increasing Credibility Over Time

<table>
<thead>
<tr>
<th>Sample 1974:1–1990:2</th>
<th>Italy</th>
<th>France</th>
<th>Belgium</th>
<th>Netherlands</th>
<th>Eire</th>
<th>Denmark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dummy = 1 1979:1–1990:2</td>
<td>0.828</td>
<td>0.280</td>
<td>2.91**</td>
<td>0.155</td>
<td>−0.027</td>
<td>1.884*</td>
</tr>
<tr>
<td>Dummy = 1 1983:1–1990:2</td>
<td>−1.968*</td>
<td>−2.155**</td>
<td>0.012</td>
<td>−2.233**</td>
<td>−2.168**</td>
<td>−2.314**</td>
</tr>
</tbody>
</table>

Each row shows the t-statistic of a dummy variable introduced to the slope parameter of the expected German inflation variable. The significance levels for the t-statistics (one sided) are 10% (*) = 1.68 and 5% (**) = 2.02.

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ERM period is assumed to be very like the pre-ERM period under the Snake and the regime shift is placed at the beginning of 1983, then the results look very different. In all countries except Belgium there is a significant decrease in the weight on expected German inflation, which is in accordance with the findings of Bini-Smaghi (1994). This is a surprising result, although as Artis and Ormerod (1996) note, inflation did fall for many OECD countries during the 1980s and the negative change to the parameter of interest may be indicating that fact. It may also suggest that the nature of the evolution of credibility is not easily detected by zero-one dummy variables. In an effort to
shed some light on this possibility we now turn to the results of Kalman filter estimation, in which the coefficients of expected German and past domestic inflation are allowed to vary over the sample. We used the full sample of data back to 1974 to generate the results, in order to allow for a ‘settling down period’ for the parameter estimates, and Figs 1–6 show the evolution of the parameters from 1976:3 with standard error bounds.

For Belgium, the coefficient of expected German inflation drops from a high initial level at the beginning of the ERM period, but increases somewhat from about 1984 onwards in a manner consistent with the positive post-1983 shift

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shown in Table 5. In the case of the Netherlands, the coefficient is consistently positive with remarkably little fluctuation, which is suggestive of strong credibility. This finding is consistent with the stability of the nominal exchange rate within the narrow ERM band and with the almost-constant real exchange rate versus the deutschmark during the sample. For Denmark, expected German inflation appears to have a coefficient close to zero throughout the sample, and the same is true for France. These results imply a lack of evidence of credibility in the ERM period. In the case of Italy and Ireland, however, the coefficient of expected German inflation is always positive. For Italy there are
some signs of an upward trend from the beginning of the ERM period up to 1985, but there is a distinct dip after that date, followed by a recovery in the late 1980s. The results for Italy and Ireland confirm the findings of Gressani et al. (1988) and Kremers (1990). The failure to find strong effects for the countries with smaller inflation differentials relative to Germany may possibly reflect the influence of noise in quarterly data obscuring the influence of the small inflation differentials. In general, the results are not as strong as for the fixed coefficient estimates and we therefore exercise caution in drawing conclusions about credibility gains in price setting behaviour.

III. CONCLUSIONS

We set out to investigate whether the ERM has enabled participating countries to obtain some of the reputation of the Bundesbank for price stability. Our argument was that, if the exchange rate commitments of the ERM were credible, inflation expectations outside Germany would be influenced by expectations of German inflation.

Our initial results suggest that the ERM did have some credibility, in the sense that domestic price-setters did set a probability greater than zero of no realignment. The probability of no realignment was rejected consistently for Belgium, Netherlands and Eire, but less so for France, Italy and Denmark, although the influence of German prices was found to operate through the real exchange rate, in levels. In these respects, these results are different from the findings of Weber (1992), who concluded that France and Italy did not gain anti-inflation reputation from the EMS. As expected, price dynamics in the United Kingdom, which did not participate in the ERM in this period, were not affected by expected rates of inflation in Germany, or by the real exchange rate. Our subsequent tests, however, using dummy variables and time-varying parameters, were less supportive of the credibility hypothesis. In neither case were we able to find any compelling evidence of a gain in credibility over the ERM period for the countries that seemed to show evidence of an ERM effect with fixed parameters. This suggests that our results should be interpreted with a certain amount of caution.

There are some obvious qualifications to be taken into account which we singled out. First, our findings are based on one model of the inflationary process which excludes any reference to monetary causes of inflation or institutional factors in wage-setting behaviour, which could be influential (Anderton et al. 1992, Anderton and Barrell, 1995). Significant events, such as the abolition of wage indexation in Italy in 1984 and the incomes policies of the Netherlands and Belgium, may have played a part in influencing price expectations, but these effects are not captured in our model. Secondly, the inflationary process in most OECD countries, both inside and outside the ERM, was rather different at the beginning than at the end of the period. In the 1970s, because of major oil price shocks, inflation rates were much higher and more volatile than at the end of the 1980s. Consequently, our estimates of the ERM effect may be contaminated by general downward shifts in

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inflationary dynamics within the OECD. These would have been transmitted more easily amongst countries with fairly fixed exchange rate arrangements in any case and in this sense it is impossible to ‘prove’ the GP hypothesis conclusively. Thirdly, the dominance of the deutschmark in the ERM and its role as an anchor currency drew persistent attention to the inflation differential versus Germany. Maintaining the central parity, avoiding realignments and pursuing disinflation became tests of political strength within Europe and evidence showing that the focus of attention on German inflation increased may reflect this change of political attitudes as much as the gains from credibility.

In interpreting these findings it is important to remember that these results do not necessarily mean that ERM exchange rates were consistent with fundamentals. Thus the results cannot be used to determine whether the credibility was sufficient to ensure sustainability of the target zone indefinitely. Some of our findings imply that the European Monetary System was credible enough to be influential in inducing lower price expectations, and that price-setting in goods markets was affected by price setting in Germany. Others suggest that the benefits were not particularly marked except for the countries with higher levels of inflation, such as Italy and Ireland. It is not possible to conclude that there is systematic evidence that countries which have participated in the ERM have been able to reap the benefits of German reputation for price stability. The results are consistent with work by other authors but the variety of experiences across member countries makes it difficult to detect any patterns which can be uniformly applied to all the ERM-participating countries.

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References


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