The reputation of a newborn central bank *

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1. Introduction

The debate on monetary policy has by and large focused on comparing different views on its effectiveness, especially in terms of the benefits of price stability as compared to the likely costs in terms of unemployment. The 'rational expectations' revolution led to a radical change in this perspective: long run equilibrium did not consider any trade-offs between inflation and unemployment. Even in the short run this outcome could be obtained, given the appropriate conditions in terms of *credibility* of the central bank. This theoretical result has been confirmed by the several alternative ways with which central banks have in practice sought to enhance their credibility, implementing one or more of the following lines: hiring a 'conservative' (i.e. inflation-adverse) central banker, defining some degree of pre-commitment (by 'tying one's hands', as with inflation targeting), or adopting some incentive-compatible contract for the central banker (as in the case of the UK, after the Bank of England reform).

In the case of a newborn central bank – like the European Central Bank, which saw the light in 1999 – these problems find no easy solution. Institutional and practical choices can help (like location in Frankfurt and the degree of independence assured by the Maastricht Treaty), although it might have been more important to show governments and financial mar-

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* We are grateful to C. Favero, P.M. Oppenheimer and to two anonymous referees for the useful comments received on a previous version of the paper. The usual disclaimers apply.

kets a solid continuity with the pre-existing central bank that had gained the best anti-inflationary reputation, i.e. the Bundesbank. This argument has already been discussed in the theoretical literature but so far has not, to the best of our knowledge, been tested empirically. Thus the main goal of the following analysis is first to develop a model of a central bank like the Bundesbank, which has *price stability* as its primary aim and *output stability* as a secondary target, and then to test the hypothesis that the very same function accounts reasonably well for the choices of the European Central Bank.

The positive results obtained from our analysis confirm the fee that had to be paid to Germany for its readiness to abandon the highly prized Deutsche Mark, but we do not conclude that all the problems have been solved. Indeed, what we have seen in recent years is that, with increasing variance in the inflationary process among the 12 euro-zone countries, monetary policy has proved ever less appropriate for each and all of the countries.

What is more, it has become an increasing burden for countries – like Germany – enjoying low inflation rates. The very importance that, in true Bundesbank tradition, the European Central Bank has attached to lowering euro-zone inflation has led to tighter monetary conditions in Germany. And, given the strictness of the Stability Pact, tighter monetary conditions have also led to a deflationary fiscal policy – an outcome undreamt of when the European Monetary Union was formed and inaugurated.

2. The Bundesbank heritage

It is usually argued that the ECB was shaped after the Bundesbank. The Maastricht Treaty famously required the ECB to pursue the single goal of price stability with no trade-off permitted between that and other goals. The ECB is allowed to pursue real economic stability only insofar as this is consistent with the goal of price stability, price stability being usually understood as zero or close to zero inflation. The main rationale for this explicit restriction, as with the adoption of monetary targets, is an attempt to ensure continuity with the past and thus ease ECB inheritance of the anti-inflationary reputation earned by the Bundesbank. Indeed, the lexico-

graphic ordering of goals is consistent with the well-known formulation of the Bundesbank's goals, where "safeguarding the currency" was interpreted as the primary goal and "supporting the general economic policy of the Federal Government, but only in so far as this is consistent with the aim of safeguarding the currency" was interpreted as the secondary goal.[1]

During the 1990s one of the main issues in the discussion of the benefits of the EMU was the credibility gain for low inflation policies. Alesina and Grilli (1993) identify the conditions which make monetary union feasible by focusing on the issue of 'how to keep Germany in'. In fact, the question they ask is, why should the country with the highest anti-inflationary reputation agree to help the other European countries gain credibility? Alesina and Grilli argue that, as the country with the lowest inflation has relatively greater bargaining power, monetary union is feasible only if the European Central Bank is entrusted to Germany. In their framework Germany is simply indifferent to the issue of whether to join the union or not so, in order to keep Germany 'in', concessions have to be made to the country.

In the present analysis we test the hypothesis that the concession made to Germany in order to make EMU feasible, implicit in the Maastricht Treaty, was to require the ECB to follow the Bundesbank's reaction function. In order to prove this we need to show that the ECB has been following the same interest rate rule as the Bundesbank, with monetary policy decisions based on German news only.

It can be argued that this concession represents an unfeasible element of fragility in the Union, as it may become difficult to bear – and hence to accept – for the other countries if and when they suffer severe shocks. But at the same time it should be remembered that, without this requirement, we could have had neither a feasible EMU nor a newborn common central bank entering upon life with a credible anti-inflationary monetary policy.

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[1] See, for instance, Svensson (1995) and von Hagen (1995).

3. Theoretical background

3.1. *A monetary policy model for the ECB*

In this section we develop a framework for examining the optimal interest rate rule for a central bank under lexicographic preferences.[2] The model considered is a stylised New Keynesian model, which is a simplified version of Clarida, Galí and Gertler (1999), and the analysis developed draws on Driffill and Rotondi (2002).

The supply function is given by a Phillips curve that relates inflation positively to the output gap

$$\pi_t = \delta E_t \pi_{t+1} + \eta y_t + v_t. \tag{1}$$

We have also an IS equation which inversely relates the output gap to the real interest rate

$$y_t = -\beta(r_t - E_t \pi_{t+1}) + u_t. \tag{2}$$

The central bank has lexicographic preferences. As primary goal the central bank has price stability, expressed as

$$L^1 = E_0 \sum_{t=0}^{\infty} \delta^t L_t^1 \tag{3}$$

with $\delta > 0$ the discount factor. The period loss function corresponding to the primary objective is

$$L_t^1 = (E_{t-1}\pi_t - \bar{\pi})^2, \tag{4}$$

where $\bar{\pi}$ is the inflation target. Expression 4 is one possible definition of price stability. An alternative definition of price stability, sometimes used in the literature, is the following:

$$E_{t-1}\pi_t = \bar{\pi}. \tag{5}$$

The problem with this latter definition is that it is too general and, as price stability is not expressed in terms of a loss function, it does not allow us to

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[2] See Driffill and Rotondi (2002) and Rotondi (2002) for an extensive analysis of monetary policy when the central bank has lexicographic preference ordering.

order the multiple solutions that satisfy the above condition.[3]

As a secondary goal the central bank has output stability, expressed as

$$L^2 = E_0 \sum_{t=0}^{\infty} \delta^t L_t^2. \tag{6}$$

The period loss function corresponding to the secondary objective is

$$L_t^1 = (y_t - \bar{y})^2 + \varphi(r_t - \bar{r}_t)^2 \tag{7}$$

with $\varphi > 0$ and r_t an operative target for the interest rate chosen according to an optimal rule that minimises the period loss function corresponding to the primary objective.

The operative target is chosen endogenously *ex post* by the central banker, after expectations are formed and before r_t is chosen, in order to achieve the primary objective. In our framework the operative target can be state contingent. As observed by Svensson (1997) and Beetsma and Jensen (1999), state contingent targeting may not be feasible in general. However in our framework, given the preferences of the central bank and the structure of the economy, it is possible for private agents to determine rationally the value of the operative target.

Note that the assumption usually made in the literature on interest rate rules is that φ is infinite, or alternatively there is no possibility of deviating from the interest rate rule. The only exception is when some degree of monetary inertia (usually due to the presence of a financial stability motive in the central bank's loss function) is explicitly introduced in the analysis. Hence the present framework is more flexible than the standard one used in the literature, and probably closer to the real world too.

3.2. *Equilibrium interest rate rule*

In the present framework the optimisation process is divided into two steps: first, the primary objective is minimised; second, as long as the first order condition for minimising the primary objective remains satisfied, it is possible to use the residual degrees of freedom to minimise the secondary objective. In other words, optimisation of the secondary objective is condi-

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[3] Price stability can also be defined in terms of price level stabilisation but, even if this is an interesting theoretical case, it is not adopted in practice.

tional on optimisation of the primary objective. Moreover, solutions which imply a lower value for L_t^1 are strictly preferred by the central banker, and similarly solutions which imply the same value of L_t^1, but a lower value of L_t^2 are strictly preferred as well.

Here we focus only on the equilibrium values prevailing in the case of discretionary monetary policy, i.e. when the policy maker is not able to pre-commit to a rule for setting the interest rate. The first order condition for minimising L_t^2 with respect to r_t is given by

$$-\beta(y_t - \bar{y}) + \varphi(r_t - \bar{r}_t) = 0. \tag{8}$$

Inserting 2 in 8 and collecting for r_t we get

$$r_t = \frac{1}{\varphi + \beta^2}\left(\beta^2 E_t \pi_{t+1} + \varphi \bar{r}_t + \beta u_t - \beta \bar{y}\right). \tag{9}$$

By inserting expression 9 back in expressions 1 and 2 we can express output and inflation as a function of the operative target r_t:

$$y_t = -\frac{\beta}{\varphi + \beta^2}\left(\beta^2 E_t \pi_{t+1} + \varphi \bar{r}_t + \beta u_t - \beta \bar{y}\right) + \beta E_t \pi_{t+1} + u_t \tag{10}$$

and

$$\pi_t = \frac{\eta}{\varphi + \beta^2}\left(\beta\varphi E_t \pi_{t+1} - \beta\varphi \bar{r}_t + \varphi u_t + \beta^2 \bar{y}\right) + \delta E_t \pi_{t+1} + v_t. \tag{11}$$

By using expression 11 for inflation we can show that the first order condition for minimising L_t^1 with respect to r_t is given by

$$E_{t-1}\pi_t = \bar{\pi}. \tag{12}$$

It is possible to show that condition 12 is satisfied by at least two rules for $\bar{r}_t$. The first rule we consider here consists in setting the target equal to a constant value given by

$$\bar{r}_t = -\frac{(\varphi + \beta^2)k}{\eta\varphi\beta}\bar{\pi} + \frac{\beta}{\varphi}\bar{y} \equiv \bar{r}, \tag{13}$$

with

$$k = 1 - \frac{\delta(\varphi + \beta^2) + \eta\varphi\beta}{\varphi + \beta^2}. \tag{14}$$

In this case the expression for inflation becomes

$$\pi_t = \frac{\delta(\varphi + \beta^2) + \eta\beta\varphi}{\varphi + \beta^2} E_t\pi_{t+1} + k\bar{\pi} + \frac{\eta\varphi}{\varphi + \beta^2} u_t + v_t, \tag{15}$$

and the first order condition for the primary objective is satisfied if, and only if,

$$\frac{\delta(\varphi + \beta^2) + \eta\beta\varphi}{\varphi + \beta^2} < 1. \tag{16}$$

Condition 16 is fulfilled for

$$\begin{aligned} 0 < \varphi < \frac{\beta^2(1-\delta)}{\delta + \eta\beta - 1} \equiv \bar{\varphi}, \quad & \text{if} \quad (\delta + \eta\beta - 1) > 0; \\ \varphi > 0, \quad & \text{if} \quad (\delta + \eta\beta - 1) < 0. \end{aligned} \tag{17}$$

Hence, reaching the price stability goal with a constant interest rate rule does not necessarily entail rigidity regarding achievement of the operative target.

The second rule we present here consistent with condition 12 is given by the following expression

$$\bar{r}_t = \frac{\delta(\varphi + \beta^2) + \eta\varphi\beta}{\eta\varphi\beta} E_t\pi_{t+1} - \frac{\varphi + \beta^2}{\eta\varphi\beta}\bar{\pi} + \frac{\beta}{\varphi}\bar{y}. \tag{18}$$

In this latter case the first order condition for the primary objective is satisfied for $\varphi>0$.

In both cases equilibrium inflation will be equal to

$$\pi_t = \bar{\pi} + \frac{\eta\varphi}{\varphi + \beta^2} u_t + v_t. \tag{19}$$

A problem with this equilibrium is that it is not clear how private agents may co-ordinate on one of the two possible rules for setting the operative target for the interest rate. One option open to the government to address this problem of multiple equilibriums would be to delegate monetary policy to a central banker with $\varphi > \overline{\varphi}$. But this solution works only if $(\delta + \eta\beta - 1) > 0$.

Alternatively, transparency of monetary policy could play an important role in this situation of strategic uncertainty about the central bank's reaction function. In fact, suppose that the central bank increases the transparency of its policy decisions by underlying the forward-looking nature of its moves. Clearly this would affect private agents by making them focus on the forward-looking policy rule 18. As explained by Orphanides (2001, p. 978): "because monetary policy operates with a lag, successful stabilization policy needs to be more forward-looking and estimated policy reaction functions should at least accommodate as much".

Actually the ECB has placed a great emphasis on the forward-looking nature of its conduct in monetary policy.[4] The ECB's stability-oriented monetary policy strategy prescribes the achievement of price stability, in terms of a 0 to 2% inflation corridor to be maintained over the medium-term. The ECB characterises successful monetary policy in the following terms:

> "Owing to the lags in the transmission process, changes in monetary policy today will only affect the price level after a number of quarters or even years. This means that central banks need to assess what policy stance is needed today in order to maintain price stability in the future, after the transmission lags unwind. In this sense, monetary policy must be forward-looking" (ECB 2001, p. 45).

Moreover, as explained by Angeloni *et al.* (2001, p. 73),

> "the medium-term orientation is partly a reflection of the time lag with which monetary policy affects prices – price developments cannot be controlled through monetary policy on a monthly or even quarterly basis. More importantly, a medium-term orientation is compatible with the role of monetary policy in the overall framework of stability oriented policies. […] The idea is that a longer time horizon allows a more

[4] Clarida, Galí and Gertler (1998) and Clarida and Gertler (1997) find forward-looking interest rate rules useful in describing Bundesbank monetary policy as well.

measured response to unforeseen shocks, thereby avoiding 'unnecessary' volatility in output, employment and interest rates".

4. Empirical analysis

4.1. *A Bundesbank interest rate rule as a benchmark*

In this section we attempt to answer the following question: does an interest rate rule framed for the Bundesbank and based only on German data continue to track closely ECB interest rates decisions?

So far the literature has used two alternative benchmarks to assess ECB monetary policy. Either it applies an estimated Bundesbank reaction function to euro zone data, or it applies an estimated common reaction function reflecting the aggregate behaviour of the EMU-members' central banks, based on a pooled data set of the pre-EMU periods. Subsequently, the interest rate projections implied by the estimated reaction functions are compared with actual ECB policy rates.

Applying the first type of benchmark researchers found the ECB rates to be consistently below those values that would have been chosen by the Bundesbank (Faust, Rogers and Wright 2001; Alesina *et al.* 2001, Galí 2001 and Clausen and Hayo 2002). This finding supports the hypothesis of an ECB 'softer' than the Bundesbank, which contradicts the discussion set out in Section 2 on a 'feasible EMU'.

By using the second type of benchmark researchers found 'remarkable' closer tracking of actual values with the interest rate projections implied by the estimated common reaction function (Mihov 2001 and Clausen and Hayo 2002). The problem with the second type of benchmark is that it uses aggregate pre-EMU variables for the interest rate, inflation and output gap, which are based on GDP-weighted averages of the national variables of Germany, France and Italy, with a relatively greater weight on German data. Hence the Lucas critique may invalidate the inference based on historical data of EMU-members and used to describe the behaviour of the ECB in the past. Clearly some caution is required when we evaluate the relevance of these findings.

More importantly, none of the studies taken into consideration examined whether during transition from the Bundesbank regime to the

ECB there actually was a structural break in the reaction function of the Bundesbank based only on German data, as implied by the findings relative to the common reaction function based on the EMU-members' historical data. This hypothesis can easily be tested by focusing on the predictive accuracy of one-step ahead forecasts obtained from the Bundesbank rule based on German data only and comparing the results obtained for the EMU period with those obtained for the pre-EMU period. In the following analysis we perform this test.

The source of the data is DATASTREAM except for German inflation and output (figures from OECD statistics) and euro zone inflation and output (from ECB statistics). We estimate for the period 1986:01-1998:12 by means of Generalized Method of Moments (GMM) the following interest rate rule for the Bundesbank

$$r_t = c_2 \cdot r_{t-1} + (1 - c_2) \cdot [c_1 + c_3 \cdot E_t \pi_{t+12} + c_4 \cdot E_t y_t]. \qquad (20)$$

Specification of the forward-looking interest rate rule for the central bank reflects the standard specification used in the empirical literature.[5] $E_t \pi_{t+12}$ is the expected 12-month ahead inflation, $E_t y_t$ is the current expected output gap, the constant c_1 corresponds to the trend nominal interest rate and ε_t is a stochastic disturbance. The output gap is measured by the percent deviation of log industrial production from a trend.[6] In our empirical analysis the interest rate used is the 1-month German euro rate for the pre-EMU period and the 1-month euribor rate for the EMU period. Usually in the empirical literature on the Bundesbank a shorter maturity is used, namely the call money rate.[7] Moreover, the target rate fitted from the estimated Bundesbank's reaction function is usually compared with the actual eonia rate for the EMU period. We instead use a longer maturity in order to ensure comparability between euro zone short-term rates and German short-term rates.[8]

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[5] See for example Clarida, Galí and Gertler (1998 and 2000).

[6] We have used the deviation of output from its long-run level as measured by the Hodrick-Prescott filter.

[7] See for example Clarida and Gertler (1997), Clarida, Galí and Gertler (1998), Mihov (2001), Faust, Rogers and Wright (2001) and Clausen and Hayo (2002). An exception is Favero (2001), who similarly to our analysis assumes that the 1-month interest rate is policy-determined and uses it for estimating an interest rate rule for the Bundesbank.

[8] In fact the German call money rate is not comparable with the eonia rate, as it is usually done by all the works quoted in the previous footnote. The call money rate is the rate paid by a broker to a bank that loaned the broker the cash that ultimately went to an

As argued first by Rudebusch (2002), the evidence on the near-observational equivalence of partial adjustment and serially correlated shocks for monetary policy rules provides a motivation for testing whether the rule expressed by 20 is mis-specified. In fact, the omission of a persistent, serially correlated variable that influences monetary policy could yield the spurious appearance of partial adjustments in the estimated rule. Indirect testing of these two alternative hypotheses, based on the evidence of the low predictability of policy rates, leads Rudebusch to the conclusion that monetary inertia is an illusion and the lagged interest rate is not a fundamental component in the case of the US policy rule. However, by testing these two alternative hypotheses directly in the estimation of the policy rule, English, Nelson and Sack (2002) show that both hypotheses play an important role in describing the behaviour of the federal funds rate.

Following English, Nelson and Sack (2002), in order to assess the presence of monetary inertia, our estimations are also based on a re-specification of equation 20, which allows for both partial adjustment and serially correlated errors. In particular, we have the following alternative specification of the interest rate rule 20:

$$r_t = r_{t-1} + (1-c_2)\cdot \Delta\hat{r}_t + [(1-c_2)(1-c_5)]\cdot(\hat{r}_{t-1} - r_{t-1}) + (c_2 c_5)\cdot \Delta r_{t-1} + \varepsilon_t. \qquad (21)$$

$$\begin{aligned} \hat{f}_t &= c_1 + c_3 \cdot E_t \square_{t+12} + c_4 \cdot E_t y_t; \\ \rho_t &= c_2 \cdot r_{t-1} + (1-c_2)\cdot \hat{f}_t + \blacklozenge_t; \\ \blacklozenge_t &= c_5 \cdot \blacklozenge_{t-1} + \mathcal{M}_t. \end{aligned} \qquad (22)$$

In expression 21 the parameter c_2 is related to the present monetary inertia (i.e. interest rate smoothing), while c_5 is related to the presence of serially correlated variables. If both parameters are significant, then both hypotheses are valid and important in explaining the behaviour of the central bank.[9]

The GMM estimates obtained from 20 and 21 are given in Table 1. We have corrected for heteroscedasticity and autocorrelation of unknown form with a Newey-West fixed bandwidth, and chosen Bartlett weights to

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investor. On the contrary the eonia rate (euro overnight index average) constitutes one of most important reference rate for unsecured transactions between banks in the euro zone money market. The first rate is mainly used for speculative investments, while the latter is mainly used for liquidity management purposes.

[9] For the case of the Fed English, Nelson and Sack (2002) have found that both hypotheses are valid. Hence, contrary to what found by Rudebusch (2002), monetary inertia is not an illusion.

ensure positive definiteness of the estimated variance-covariance matrix.[10] We have taken as instruments the first 6 lags of the German inflation rate, output gap and 1-month euro rate.

As can be seen from Table 1, the estimates of c_2 and c_5 are both highly significant in the specification 21 of the interest rate rule of Bundesbank. This result suggests that both partial adjustment and serially correlated errors are present. Moreover, allowing for serially correlated errors does reduce the estimated degree of partial adjustment to some extent, but the effect is small, with the c_2 parameter falling from 0.91 to 0.86.

In Figure 1 we compare the euro zone 1-month interest rate with the fitted target rates derived from the estimated Bundesbank reaction function 20, based alternatively on German and euro zone data. First, we focus on euro zone data. In this case, we confirm partially the findings of euro zone interest rates being lower than the fitted target rates, as we can observe also several periods of overlapping. Moreover, we do not find the large discrepancies between actual rates and fitted target rates found for the first year of EMU by Faust, Rogers and Wright (2001).

The new insight deriving from our analysis emerges when we consider the estimated Bundesbank reaction function and compare the case of central bank reaction to German news with its reaction to euro zone news. As shown in Figure 1, the target rates based on German data are closer to actual values than those based on euro zone data. The above results can be examined further from Table 2, where the one-step ahead forecasts derived from the estimated reaction functions are given.[11] It can be observed that the target rates based on German data have a predictive accuracy superior to that of the target rates based on euro zone data.

TABLE 1

GMM ESTIMATION OF THE EQUATION OF THE 1-MONTH GERMAN RATE

	Equation 20	Equation 21
c_1	1.39	1.18
	(0.37)	(0.44)
c_2	0.91	0.86
	(0.02)	(0.04)

[10] As starting values for the coefficients we have considered Two-Stage Least Squares estimates.

[11] In Table 2, in order to compute the predictive accuracy of the one-step ahead forecasts for the pre-EMU period, we have re-estimated specifications 20 and 21 over the sample 1986:01-1996:02. Nevertheless the observations included in the forecast sample are always the same: 34 months.

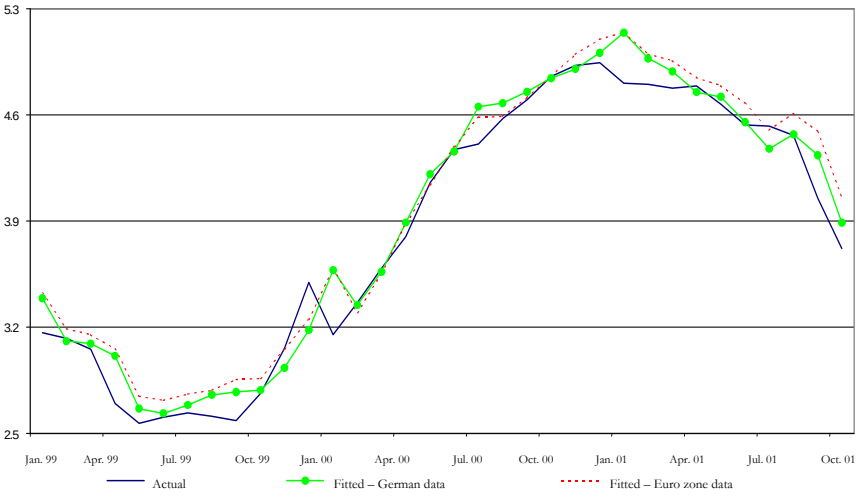
c_3	1.61 (0.17)	1.88 (0.19)
c_4	0.69 (0.19)	0.59 (0.18)
c_5		0.21 (0.05)
R Squared	0.99	0.98
S.D. dependent variable	2.23	2.23
S.E. regression	0.27	0.31
J-Statistic	7.19	6.07

Notes: robust standard errors in parentheses.

Mihov (2001) finds a root mean squared error of 0.19 for the estimated common reaction function, based on pooled EMU data, for the EMU period, and describes as 'remarkable' the close tracking of actual values by his estimates. However, to our case of the target rates derived from the Bundesbank rule and based on German data corresponds a root mean squared error of 0.16 for the EMU period. Moreover, transition from the pre-EMU period to the EMU period did not imply a significant break for the Bundesbank from the point of view of the predictive accuracy of the fitted target rates based on German data. This is particularly evident for the specification 20 of the interest rate rule.

FIGURE 1

COMPARISON BETWEEN 1-MONTH EURIBOR RATE AND THE TARGET RATES FITTED FROM THE ESTIMATED BUNDESBANK'S REACTION FUNCTION



The latter result represents also a convincing argument against the hypothesis of the ECB being 'softer' than the Bundesbank. The presence of a positive spread between target rates corresponding to a Bundesbank rule based on EMU data and actual ECB rates has led some researchers to suggest that the ECB reaction function might feature a greater weight on the output gap relative to the weight on inflation, as compared to the Bundesbank (see, for instance, Faust, Rogers and Wright 2001). On the contrary, our findings clearly reject this hypothesis.

Hence, from the German perspective, transition to EMU did not imply a substantial modification in the conduct of monetary policy, as the presence of the majority vote mechanism in the ECB would, instead, have suggested. In conclusion, according to our empirical evidence, it can be argued that the concession made to Germany in order to make EMU feasible, implicit in the Maastricht Treaty, was to require the ECB to follow the Bundesbank reaction function.

TABLE 2

FORECAST DIAGNOSTICS OF ONE-STEP AHEAD FORECASTS
FOR THE ESTIMATED REACTION FUNCTIONS

	German data				Euro zone data			
	Bundesbank 1996:03-1998:12		Bundesbank 1999:01-2001:10		Bundesbank 1999:01-2001:10		Fed 1999:01-2001:10	
	$c_5 = 0$	$c_5 \neq 0$	$c_5 = 0$	$c_5 \neq 0$	$c_5 = 0$	$c_5 \neq 0$	$c_5 = 0$	$c_5 \neq 0$
Root mean squared error	0.13	0.15	0.16	0.22	0.19	0.26	0.20	0.18
Mean absolute error	0.11	0.12	0.12	0.17	0.15	0.23	0.16	0.14
Mean absolute percentage error	3.21	3.67	3.35	4.81	4.27	6.45	4.10	3.78
Theil inequality coefficient	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.02

4.2. *A Fed-in-Frankfurt interest rate rule as a benchmark*

In this section we compare the behaviour of the ECB with that of the Fed. In particular we apply an estimated Fed reaction function to euro zone data.[12] As before, the interest rate projections implied by the benchmark reaction function are compared with actual ECB policy rates.

During 2001 the Fed cut its policy rate more often and by a greater amount than the ECB. Some commentators praised the aggressive orientation of the Fed monetary policy, underlining its adroitness in stimulating the economy without compromising the achievement of price stability. On the contrary, the ECB has been criticised for being slow in responding to macroeconomic shocks. An interesting question here is to ask whether the reason for this different behaviour of the ECB was due to continuing investment in the build up of credibility.

The existing empirical evidence does not clearly show that the ECB was more passive than a Fed-in-Frankfurt would have been. For instance, Begg *et al.* (2002) have found that in 2001, while the ECB was initially slow in reacting to euro zone news, the counterfactual rate based on the Fed rule was very close to actual rates.[13] However, in the first two years of

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[12] A related issue examined in the literature is whether the ECB has followed the Fed in the timing of its moves (see for instance CEPS 2002). Here we examine only what would have happened if the Fed was in charge of monetary policy decisions in EMU.

[13] The interest rate used in their empirical analysis is the rate on main refinancing operations of the ECB. However, in order to ensure comparability between euro zone and US

EMU the actual rates are consistently lower than the counterfactual rates based on the Fed rule.

Let us examine our findings. In this case the sole source of the data is DATASTREAM. In Table 3 we report the GMM estimates of specifications 20 and 21 for the Fed. Here, we have taken as instruments the first 6 lags of the US inflation rate, output gap, 1-month euro rate and Fed Funds rate.

As will be seen in Table 3, the estimates of c_2 and c_5 are both highly significant in the specification 21 of the Fed rule. Again, allowing for serially correlated errors does reduce the estimated degree of partial adjustment to some extent, but the effect is small, with the c_2 parameter falling from 0.91 to 0.88. Note that it falls slightly less than in the case of the Bundesbank. In both cases the degree of monetary inertia, as measured by the parameter c_2, remains high.

In Figure 2 we compare the euro zone 1-month interest rate with the fitted target rates derived from the Bundesbank rule based on German data and those derived from the Fed rule based on euro zone data, both under the specification given by 20. It is interesting to observe the almost perfect overlap of the two counterfactual rates up to October 2000. Subsequently they diverge, with the Bundesbank target rate consistently lower than that of the Fed. Moreover, in 2001 the actual rate is consistently lower than the counterfactual rate derived from the Fed rule, apart from July, while the counterfactual rate derived from the Bundesbank presents some overlapping periods.

In conclusion, our findings do not support the hypothesis that the ECB has been passive in responding to macroeconomic shocks. Indeed, contrary to the standard findings obtained in the empirical literature and the opinion commonly held by ECB watchers, in 2001 the ECB reduced its short-term interest rate more aggressively than a Fed-in-Frankfurt would have done.

Moreover, according to our empirical evidence a 'Bundesbank-in-Frankfurt' would have replicated the ECB behaviour fairly closely compared to a Fed-in-Frankfurt.

TABLE 3

GMM ESTIMATION OF THE EQUATION OF THE 1-MONTH US RATE

	Equation 20	Equation 21

interest rates, a 1-month interest rate would be better. For this reason we estimate the Fed rule by using US 1-month euro rates and apply it to 1-month euribor rates.

c_1	1.99 (0.85)	4.33 (0.39)
c_2	0.91 (0.02)	0.88 (0.03)
c_3	1.24 (0.25)	1.45 (0.29)
c_4	1.24 (0.29)	1.11 (0.23)
c_5		0.55 (0.06)
R Squared	0.97	0.97
S.D. dependent variable	1.69	1.69
S.E. regression	0.28	0.32
J-Statistic	23.35	23.18

Notes: robust standard errors in parentheses.

5. Conclusions

In a previous paper,[14] we had already suggested some degree of continuity between the Bundesbank and the European Central Bank; and we used that argument along with other econometric evidence to test the hypothesis that the new currency, the euro, had closely followed in the footsteps of its illustrious predecessor, the Deutsche Mark.

We have now further developed the comparison between the Bundesbank and the European Central Bank. For the first time we test empirically the Alesina and Grilli (1993) conditions for 'keeping Germany in'. And for the first time, we develop – and compare – the 'lexicographic model' of monetary policy for both the Bundesbank and the European Central Bank. We also estimate the role of data referring to Germany alone (*vs.* the entire euro-zone) in the European Central Bank reaction function. Finally we make some progress on one specific, but important, aspect of European Central Bank policy in recent years, which was criticised for being too slow to act, compared with the Federal Reserve's much faster and much more flexible reaction.

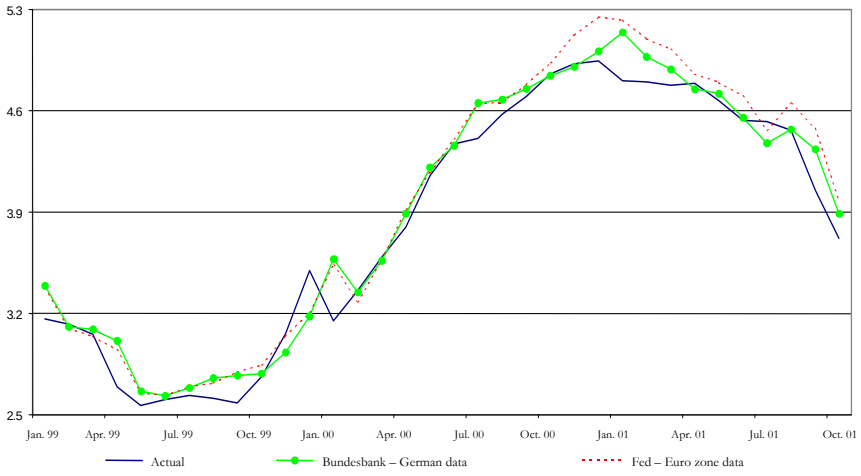
In fact, the credibility of the American central bank in recent years has been largely based on its aggressive stance against the economic cycle (and several disruptive shocks). Our new European institution has largely

[14] See Rotondi and Vaciago (2002).

followed the opposite approach, stability in its policies being considered an important means to achieve the final goal of monetary stability. Our analysis does not support the commonly made criticism that the European Central Bank was too slow to act.

FIGURE 2

COMPOSITION BETWEEN 1-MONTH EURIBOR RATE AND THE TARGET RATES FITTED FROM THE ESTIMATED BUNDESBANK'S AND FED'S REACTION FUNCTION



Our final conclusion is therefore more positive than that of most European Central Bank watchers. The approach chosen to achieve credibility was correct, while most of the problems that the European Central Bank has encountered are due to the slow progress made in improving the quality of the monetary union. The increasing variance of the inflationary process among the 12 countries, especially at the extremes of income level distribution – between Germany and Portugal, say – has meant that the common monetary policy is not yet the best possible. The quest for an optimum currency area continues.

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