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In 2006 all ECB publications will feature a motif taken from the €5 banknote.

1 The paper does not necessarily reflect views of either the European Central Bank or the European University Institute.

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Abstract

Despite the great importance and final success of the convergence process that led to the establishment of the European Monetary Union, there is no clear agreement regarding the monetary policy pursued in the member countries during the convergence process. This paper contributes to the literature with an empirical analysis of the period from 1993 to 1998 that encompasses eleven EMU countries. In particular, Taylor-type interest rate rules are estimated with monthly national data to find that, despite certain similarities and exceptions, the rule followed by each country is distinct and differs substantially from the standard Taylor rule. However, for most countries, the parameter estimates reflect the principles proclaimed by the monetary policy authorities and, in addition, it is shown that in most cases the estimated rules reproduce the policy setting quite closely.

Keywords: Taylor rule, ERM, output gap, monetary policy

JEL-classification: E58, F41

Non-technical summary

Despite the great importance and final success of the convergence process that led to the establishment of the European Monetary Union, there is no clear agreement regarding the monetary policy pursued in the member countries during this important period. This paper contributes to the literature with an empirical analysis of the period from 1993 (i.e. after the signing of the Maastricht Treaty and after the end of the 1992 EMS crisis) to the end of 1998 (i.e. just before the start of Stage Three of EMU that encompasses eleven EMU countries.

In particular, Taylor-type interest rate rules are estimated with monthly national data to find that, despite certain similarities and exceptions, the rule followed by each country is distinct and differs substantially from the standard Taylor rule. In particular, given the fact that the standard Taylor rule specification does not seem to yield satisfactory results, the analysis proceeds by estimating variants of the standard Taylor rule that include additional variables in order to better capture the actual conduct of the monetary policy followed by each of the EMU-12 member states. As regards the choice of the specifications, it is mainly motivated by the approaches in the existing literature and the distinctive features of the actual monetary policies of the countries themselves.

While the analysis shows that each country's rule is individual, the importance of the German rate is in all cases undisputable. For most countries, the parameter estimates reflect the principles proclaimed by the monetary policy authorities and, in addition, it is shown that in most cases the estimated rules reproduce the policy setting quite closely.

The target rate series derived from the appropriately augmented selected specifications achieves a considerable correlation with each country's historical interest rate series. Moreover, the estimated parameters take plausible values in almost all cases, establishing in this way the merit and usefulness of the exercise undertaken here.

1 Introduction

Is there a common rule that captures policy setting in the Economic and Monetary Union (EMU) member countries during the period from 1993 to 1998? How far are Taylor-type rules relevant and informative at the national level? As a matter of fact, at the aggregate level, various authors have shown that even before 1999 the average interest rate of the EMU countries moved quite closely in response to average output gaps and inflation as suggested by the Taylor rule (including an interest rate smoothing parameter). However, this evidence does not answer the questions regarding the mechanisms in function at the national level, where idiosyncrasies and divergent starting conditions usually matter a great deal.[1] Thus, the present paper is based on a large-scale project that encompasses all EMU members and focuses exclusively on the post-Maastricht period in an attempt to provide researchers and practitioners with constructive conclusions.[2] In this context, it is worth pointing out the importance of empirical findings derived with data from countries that are not frequently analysed such as, for instance, Greece and Portugal.

Another issue to be explored is whether the principles of monetary policy setting, as announced by the authorities in view of the convergence process, are adequately captured. How do they perform in an empirical set-up? Are there significant differences across member countries? The exploration of these issues offers a better understanding of a historical period of crucial importance for the European integration process and at the same time is also valuable for the future, as it can be useful for the European Central Bank (ECB henceforth) to shed some light on country-specific affairs. Of course, these considerations are subject to the fact that one should keep in mind the restrictions under which monetary policy functioned during this transitory period.

When doing this type of analysis, it should be borne in mind that an empirical estimation of the parameters of a simple interest rate reaction function is not intended to capture the exact way in which the central banks react to economic conditions. Instead, it is meant to capture the inherent and implicit way in which economic indicators entering the specified rule are taken into account in a central bank's decision. In other words, the empirical exercise presented in this paper does not imply that central banks actually follow, or should follow, a Taylor rule. Nonetheless, it

[1] To mention some studies with analyses at the aggregate level: Gerlach and Schnabel (2000), Favero et al. (2000), Mihov (2001), Gerdesmeier and Roffia (2003) and Eleftheriou (2003).

[2] Luxemburg is, however, excluded from the analysis due its very small size and the dependence of its policies on those pursued in the bordering countries.

represents an interesting piece of work that responds to few critical questions which have been outlined at the start.

The paper is structured as follows. The next section gives a brief survey of the related literature while Section 3 discusses some issues associated with the empirical analysis and presents the results at a country level breakdown. The last section concludes. Appendix A at the end of the paper provides an exhaustive description of the main features of the monetary policy of each country that serves the basis for the selection of the specifications of the Taylor rule which will be employed in our analysis.

2 Literature Review

Due to the large number of countries involved in the analysis, it is basically impossible to have entirely country-specific models. Thus, as already revealed, for the sake of simplicity and comparability, we intend to assess whether the central banks' response can be summarised by an interest rate rule, namely the well-known Taylor rule (Taylor (1993)), and draw conclusions on the relevance of the parameters' estimates. The rule derives the economy's target interest rate value (generally known as Taylor-rule rate) as a function of the state of the economy, which is usually described by the deviation of actual inflation rate from an inflation target and of actual output from its long-run potential level.

Despite the characterisation of the rule as simple, there are a number of practical and theoretical issues complicating its estimation. The interested reader is referred to Eleftheriou (2003) for an examination of the various uncertain issues associated with its specification − which include, *inter alia*, the variables entering the rule, their role, their dating and their calculation − and for a detailed description of the developments concerning this monetary policy rule. In this section we present the main studies that look into the monetary policy of the EMU member countries.

Given the large number of studies on this topic, a review inevitably needs to restrict itself to just a selection of them. The main purpose of our review is to present the empirical findings of the literature, also by underlying their similarities and differences, as well as the methodological approach chosen in various cases.[3]

Unambiguously, the most established reference among the studies which estimate Taylor-type interest rate rules is the paper by Clarida, Gali and Gertler (1998), referred to as CGG henceforth. The authors explore the monetary policy in Germany, France and Italy, as well as in

[3] Additionally, the reader is referred to Section 3 for studies focusing on individual countries and, especially for Germany, to Eleftheriou (2006) for a review of studies applying different approaches.

other countries outside the euro area. Their baseline specification encapsulates an interest rate smoothing term and is specified in a forward-looking way, in the sense that inflation is measured by the one-year ahead realised value, while they also additionally experiment with lagged inflation. The estimation method implemented is GMM and in the baseline model the instrument set includes lagged values of output, the inflation rate and commodity prices.[4] The set is expanded accordingly to capture policy objectives other than inflation and output by including additional variables such as the money stock, exchange rate or a foreign interest rate. The sample period used differs depending on the country and its involvement in the Exchange Rate Mechanism (ERM) of the European Monetary System (EMS). More specifically, the period 1979.4-1993.12 for Germany, 1983.5-1989.12 for France and 1981.6-1989.12 for Italy (for France and Italy the estimation period finishes when the country enters the hard ERM) are considered.[5]

Another often cited paper is that by Dornbusch, Favero and Giavazzi (1998). The authors explore monetary mechanisms in Europe by estimating simultaneously − by means of Full Information Maximum Likelihood − central bank reaction functions for Germany, France, Italy and Spain. Their monthly data cover the period from 1985 to mid-1995. For Germany, the specification used is quite standard, as the right-hand-side variables are domestic inflation, a measure of the output gap and the trade-weighted exchange rate vis-à-vis other European countries. For the other countries, the specification is less common as it includes the gap between domestic and German inflation, the gap between domestic and German industrial production, the first difference of the Deutschemark-US dollar exchange rate and, finally, the German interest rate. For the stability check, an out-of-sample forecast test is applied and stability is not rejected. Another study closely related to this, which also applies a simultaneous equations approach, is that by Clausen and Hayo (2002).

A similar sub-set of euro area countries (i.e. Germany, France, Italy, Spain and the Netherlands) is also analysed by Angeloni and Dedola (1999). The two authors estimate a set of bivariate systems of equations, each including Germany and another country. This "pairwise" modelling strategy is chosen in light of the fact that German monetary conditions are likely to have been relevant for each of the country concerned. The explanatory variables include the lagged dependent variable, the foreign interest rate, a measure of the money stock and a measure

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4 CGG report a test of overidentifying restrictions and that the estimates are obtained with a correction for MA (12) autocorrelation. Additionally, they note that the optimal weighting matrix is obtained from first two-stage least square parameter estimates.

5 Some related studies applying a framework more or less similar to CGG are Wyplosz (1999), Peersman and Smets (1999), Smant (2002) and Altavilla (2003).

of the exchange rate. The specifications also include either both future and past inflation together, or each of them separately. The data are monthly observations for the period 1980-1997 and the sample is split into two sub-periods in 1987 in order to compare the evolution of the estimates over time. The estimation method used is GMM.[6]

In the same vein, Muscatelli, Tirelli and Trecroci (2003) focus on the same period (1980 Q1-1997 Q2) and analyse monetary policy in France, Belgium, Italy and Ireland. Their specification is forward-looking but not quite standard since, in addition to the lagged interest rate and to an alternative measure of expected inflation and expected output gap, they also use the long-term yield spread vis-à-vis Germany as well as the German interest rate. Furthermore, the relevance of monetary aggregates is also taken into account. The estimation method used is Recursive Least Squares and, along with some basic misspecification tests, stability is checked by performing Chow tests. The obtained recursive coefficients track shifts which are claimed to be due to the EMS development. In a previous paper, Muscatelli, Tirelli and Trecroci (2002) applied the same technique of the Recursive Least Squares method by focusing exclusively on monetary policy in Germany.[7]

In a noticeably different framework, Ruth (2004) applies panel techniques to country-specific data from ten EMU members and estimates interest rate reaction functions within an error-correction model for the period 1993 to 1999. For some specifications, the panel varies either to exclude Austria, Belgium and the Netherlands (as it is argued that these countries did not pursue an active monetary policy) or to include only the three largest economies, namely Germany, France and Italy (in order to explore whether and how the results depend on the panel formation). In line with the rest of the literature, the ERM implications are explored by including the German rate as an additional regressor in the reaction functions of all the countries but Germany for which the US Federal Funds rate is included.

Last but not least, there is a growing literature on time-varying policy rules, for a general discussion of which it is recommended, among others, Wesche (2003) who estimates interest rate equations (using German, French and Italian data for the period 1973-1998) by means of a Markov-switching model and shows that, over time, all the central banks assigned changing

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6 Regarding GMM, Angeloni and Dedola (1999) compute the weighting matrix using Andrews (1991) data dependent method and they report a test on the validity of the overidentifying restrictions.

7 In their paper they initially calculate a measure of expected inflation and output gap, and then regress the nominal interest rate on these plus on lags of the dependent variable. Additionally, they consider specifications augmented with the Federal Funds rate, money growth and the exchange rate. Based on a long sample period (1970 Q2-1992 Q2) they conduct recursive analysis and structural stability tests (Chow tests) so as to detect breaks. Based on the results of these tests, they re-estimate the reaction function over the post 1980 period, and again perform recursive tests and stability analysis. The estimation method is Recursive Least Squares, and a battery of tests is also reported.

weights to inflation and the output gap. In connection with the EMS, for France and Italy the German interest rate had an influence especially until around 1983 and, only for the former, also around the German unification. In a similar context, Dolado, María-Dolores and Naveira (2000) estimate asymmetric reactions to inflation for France, Germany and Spain by using dummy variables for inflation above and below target.[8] The sample periods vary according to country starting no later than 1989 and finishing in 1997 in all cases. According to their findings, the central banks − and in particular the Bundesbank − intervened much more strongly when inflation was above target than when below it. Conversely, they did not seem to react differently to the ups and downs of the output gap. Finally, Arghyrou (2005) estimates non-linear reaction functions for Greece (for the period 1991- 2000).

The table below summarises the main findings of these studies by reporting, *inter alia*, the specifications which were adopted as well as the variables which best described the monetary policy conduct of the countries under consideration. Some observations are worth being mentioned. First, most of the studies are based on monthly data. Second, in most of the studies the estimations are run over the 1990s sub-sample, which is in line also with our approach. As a matter of fact, this period of the convergence process is characterised by more homogenous aspects and excludes the ERM crises. Finally, in many cases the augmented Taylor rules (which include the smoothing term) seem to describe better the monetary policy of the countries. In particular, the German interest rate is very often regarded as an important determinant for the euro area countries under analysis.

Table 1 Summary of Taylor rule specifications in the literature

Authors	Countries, samples and frequency	Variables	Preferred specification
Clarida, Gali and Gertler (1998)	Germany: 1979.04-1993.12 France: 1983.05-1989.12 Italy: 1981.06-1989.12 Monthly	Germany: $i_t = f(\pi_{t+k}, \pi_{t-k}, y_{gap}, \Delta M, i_t^{US}, \Delta DM/\$, i_{t-k})$ France: $i_t = f(\pi_{t+k}, \pi_{t-k}, y_{gap}, i_t^{DE}, \Delta FFR/ECU, i_{t-k})$ Italy: $i_t = f(\pi_{t+k}, \pi_{t-k}, y_{gap}, i_t^{DE}, \Delta LIR/ECU, i_{t-k})$	Germany: $i_t = f(\pi_{t+k}, \pi_{t-k}, y_{gap}, i_{t-k})$ France: $i_t = f(\pi_{t+k}, \pi_{t-k}, y_{gap}, i_t^{DE}, i_{t-k})$ Italy: $i_t = f(\pi_{t+k}, \pi_{t-k}, y_{gap}, i_t^{DE}, i_{t-k})$
Dornbusch, Favero and Giavazzi	Germany, France, Italy and Spain 1985.04 -1995.04	Germany: $i_t = f(\pi_t, y_{gap}, i_{t-k})$ France, Italy and Spain:	Germany: $i_t = f(\pi_t, y_{gap}, i_{t-k})$ France:, Italy and Spain:

[8] See also Surico (2003) who focuses on euro area data.

(1998)	Monthly	$i_t = f(\pi_t, y_{gap}, i_t^{DE}, \Delta DM/\$, i_{t-k})$	$i_t = f(\pi_t, y_{gap}, i_t^{DE}, \Delta DM/\$, i_{t-k})$
Angeloni and Dedola (1999)	Germany, France, Italy, Spain and Netherlands: 1980.01-1987.12 and 1988.01-1997.04 Monthly	Germany: $i_t = f(\pi_{t+k}, \pi_{t-k}, y_{gap}, \Delta M3, i_t^{US}, \Delta DM/\$, i_{t-k}, REER)$ France, Italy, Spain and Netherlands: $i_t = f(\pi_{t+k}, \pi_{t-k}, y_{gap}, \Delta M3, i_t^{DE}, \Delta DM/\$, i_{t-k}, REER)$	Germany: $i_t = f(\pi_{t+k}, \pi_{t-k}, y_{gap}, i_t^{US}, \Delta DM/\$, i_{t-k})$ France, Italy, Spain and Netherlands: $i_t = f(\pi_{t+k}, \pi_{t-k}, y_{gap}, i_t^{DE}, \Delta DM/\$, i_{t-k})$ First period: bad fit of augmented Taylor rule Second period: good fit
Clausen and Hayo (2002)	France, Germany and Italy 1979.1 – 1996.4 Quarterly	All countries: $i_t = f(\pi_t, y_{gap}, i_{t-k}, D_{81}, D_{92})$.	All countries: $i_t = f(\pi_t, y_{gap}, i_{t-k}, D_{81}, D_{92})$
Muscatelli, Tirelli and Trecroci (2003)	France, Italy, Ireland and Belgium 1980.1 to 1997.2 Quarterly	$i_t = f(\pi_{t+k}, y_{gap}, i^{DE}; lt - lt^{DE}; \Delta M3, \Delta M1, \Delta RES, i_{t-k})$	$i_t = f(\pi_{t+k}, y_{gap}, i^{DE}, lt - lt^{DE}, i_{t-k})$
Ruth (2004)	Austria, Belgium, Netherlands, Finland, France, Italy, Germany, Portugal, Spain and Ireland 1993.01-1998.12 Monthly	$i_t = f(\pi_{t+k}, y_{gap}\ lt, i_{t-k})$	$i_t = f(\pi_{t+k}, y_{gap}\ lt, i_{t-k})$
Wesche (2005)	Germany 1973.1-1998.4 Quarterly	$i_t = f(\pi_{t+k}, y_{gap}\ lt, i_{t-k})$	$i_t = f(\pi_{t+k}, y_{gap}\ lt, i_{t-k})$
Arghyrou (2005)	Greece 1991.4-2000.4 Quarterly	$i_t = f(\pi_t, y_{gap}, y_{gap,t-k}, i_{t-k})$	$i_t = f(\pi_t, y_{gap}, y_{gap,t-k}, i_{t-k})$
Surico (2003)	Germany 1992.2-1998.12 Monthly	$i_t = f(\pi_t, y_{gap}, i_{t-k})$	$i_t = f(\pi_t, y_{gap}, i_{t-k})$

Note:
i = short-term interest rate, π = inflation rate, y_{gap} = output gap, $DM/\$$ = real Deutschmark/Dollar exchange rate, FFR/ECU = Franc/ECU exchange rate, LIR/ECU = Lira/ECU exchange rate, M = money supply, REER= real effective exchange rate, lt = long-term interest rate, RES = foreign exchange reserves.

Overall, in the present paper, the estimation period is rather short for such long-term enquiries and besides, as the period under focus predates EMU, the strategy of almost all the central banks was dominated (or restricted) by the final objective of joining the euro area. Moreover, two main aspects differentiate the present paper from existing studies: first, it covers a different period with unique features and, second, it widens the existing research on Taylor-type reaction functions for all euro area economies.

3 Empirical Analysis

As a starting point, it seems worth noting that the empirical analysis of the present section assumes all the variables involved to be stationary within the sample period.[9] This standpoint is commonly acknowledged despite the ambiguous evidence (see CGG (1998) for a discussion on this issue). Nonetheless, there is a growing literature highlighting the potential hazards arising from neglecting the non-stationarity of the variables and modelling Taylor-type rules in alternative frameworks (see for instance Gerlach-Kristen (2003) and Eleftheriou (2006)).

3.1 Background information

3.1.1 Dataset

With regard to the data used in the estimations, Appendix C offers detailed information about the series, while the present section explains the transformations employed in the Taylor rule specifications. In particular, the inflation rate is measured by the year-on-year difference of the natural logarithm of the price series while the output gap is generally represented by the residuals from regressing the output series on a linear trend. The exchange rate is measured by the month-to-month difference of the logarithm of the respective series (national currency vis-à-vis the German mark or vis-à-vis the US dollar for Germany). Likewise, for all the countries, except for Germany, the money stock is measured by the month-on-month difference of the logarithm of the M3 series.

In the case of Germany, the money stock series is derived by subtracting from the year-on-year difference of the logarithm of the M3 series the upper limit of the announced annual growth rate, in line with the monetary targeting regime followed by the Bundesbank. In the case of Spain, developments in economic activity are captured not by an output gap variable but by the year-on-year difference of the unemployment rate with the sign switched around, given the

[9] For Belgium, Germany, Portugal and Finland there is evidence of non-stationary interest rate, inflation and output gap series. In the case of Greece and Italy the interest rate and inflation series were found stationary and the output gap non-stationary, while for Ireland the opposite. For Spain, France, the Netherlands and Austria there is evidence of stationary interest rate series.

severity of the unemployment problem in the country and the high commitment of the Spanish authorities to fight unemployment.[10]

To check the sensitivity of the results with respect to the method used for the calculation of the output gap, a robustness analysis is performed for the preferred specifications. In addition to the linear trend (denoted as "lt" in the associated Table B1 in the Appendix B) and the Hodrick- Prescott filter (denoted as "hpf"), two additional methods are checked: the first one measures the output gap by the residuals from the regression of output on a quadratic trend (denoted as "qt" in the associated table), while the second one calculates the output gap by means of the Band-Pass filter run again on the output series.[11]

3.1.2 Technique and instrument set

For the sake of comparability with the major findings in the literature, the estimation method used is the Generalised Method of Moments (GMM).[12] The weighting matrix is the heteroscedasticity and autocorrelation consistent (HAC) covariance matrix which implies that the estimates are robust to heteroscedasticity and autocorrelation of any form. The starting values of the iterations are supplied by the Two Stage Least Squares (TSLS) estimators and, given that there are more instruments than parameters to be estimated, the validity of the overidentifying restrictions is tested by means of the *J-statistic*: under the null that the restrictions are satisfied, the *J-statistic* times the number of the regression observations is asymptotically χ^2 with degrees of freedom equal to the number of overidentifying restrictions.[13] Apart from this standard diagnostic for model specification within the GMM framework (see Hall (2005)), the Ljung-Box Q-statistic (denoted as Q-stat) is also reported for the preferred specifications.[14]

As regards the instruments set, following CGG, in the baseline specifications it includes lagged values (1-6, 9, 12 lags in most cases) of the following series: the interest rate, the inflation rate, the output gap, the exchange rate measure and the (month-on-month difference of the logarithm of a) world commodity price index. The instrument set of the augmented specifications includes lagged values (1-6, 9, 12 lags in most cases) of the additional variables.

[10] In this way, a negative value of this measure has the same effect on the rule as a negative output gap value, i.e. requests a policy tightening.

[11] The Band-Pass filter was proposed by Baxter and King (1999). See Eleftheriou (2003) for a detailed discussion.

[12] Results do not generally differ if a different IV estimation method, such as the Two Stage Least Squares (TSLS) were used. The results of this estimation are available from the authors upon request.

[13] The values reported in the tables correspond to the p-value.

[14] The Q-stat is a test statistic for the null hypothesis that there is no autocorrelation up to the indicated lag order and under the null hypothesis is asymptotically distributed as X^2 with degrees of freedom equal to the number of autocorrelations.

In the case of Germany, the instrument set of all the specifications, is amplified with the corresponding money stock series and the US interest rate, although the latter is dropped in the specification with both the exchange rate and the money measure.

3.1.3 Specifications

As discussed, the present study aims at describing monetary policy during the convergence process towards Stage Three of the Economic and Monetary Union. Thus, the estimation period starts in 1993, i.e. after the signing of the Maastricht Treaty and after the end of the 1992 EMS crisis, and finishes in 1998, i.e. just before the start of Stage Three of EMU. However, in order to check the robustness of the derived results, a shorter period, starting in August 1993 (i.e. the first month after the widening of the EMS exchange rate bands to ± 15%) and finishing in April 1998 (i.e. the last month before the initial EMU member countries were selected and their bilateral central rates had been fixed) has also been analysed. However, the final results remain basically unaffected, with the exception of Italy and Finland and, to a lesser extent, Belgium.[15]

To get an idea about the relevance of the Taylor rule, the empirical analysis for each country starts with a baseline specification that features interest rate smoothing which is described by the following equation:[16]

$$i_t = (1-\rho)\alpha + (1-\rho)\beta\pi_{t+n} + (1-\rho)\gamma x_{t+m} + \rho i_{t-1} + \varepsilon_t , \qquad (1)$$

where π_{t+n} and x_{t+n} stand for the inflation and the output gap measure respectively (with β and γ referring to as the inflation and the output gap coefficients respectively), whereas ρ represents the interest rate smoothing coefficient. Regarding the timing, n may be equal to 0, +6 or +12, thus denoting a contemporaneous or forward-looking specification respectively, while m equals 0 in all cases. Finally, ε_t is the error term. Regarding the interpretation, to put it briefly, if β>1, the increase in the nominal rate is greater than the rise in the inflation rate and thus the real rate increases to bring down inflation and, if γ>0, the target rate adjusts to stabilize output.

To achieve a better fit, additional smoothing has been necessary in two cases by including an additional lag of the interest rate, so that equation (1) is modified as follows:

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15 Note that after the announcement of the Ins, monetary policy conduct in these countries was an atypical task given the established 'end-point' restrictions- see Begg et al. (1997) and Obstfeld (1998) for a discussion. For Greece, Austria and Finland, the starting date is not modified since these countries entered the EMS after the widening of the bands. Also, only in the case of Greece, the last observation of the modified shorter period is June 2000, as its admission was announced on 19 June 2000.

16 Regarding the importance of interest rate smoothing see among others Goodfriend (1991), Woodford (1999), Orphanides (1998) and Rudebusch (1995, 2002).

$$i_t = (1-\rho_1-\rho_p)\alpha + (1-\rho_1-\rho_p)\beta\pi_{t+n} + (1-\rho_1-\rho_p)\gamma x_{t+m} + \rho_1 i_{t-1} + \rho_p i_{t-p} + \varepsilon_t . \qquad (2)$$

In some other cases, dummy variables have proven useful in capturing extraordinary events in some countries. For the sake of brevity, let us just portray here the least simple case, i.e. the specification employed for Spain:

$$i_t = (1-\rho)\alpha + (1-\rho)\beta\pi_t + (1-\rho)\gamma x_t + (1-\rho)(D1date) + (1-\rho)(D2date)x_t + \rho i_{t-1} + \varepsilon_t \qquad (3)$$

where the dummy variables *D1date* and *D2date* equal 1 in the dates indicated in their name and zero otherwise and the first is linked with the constant while the second with the gap coefficient.

The empirical analysis goes on to explore the relevance of a number of factors which are likely to affect the monetary policy setting during the period under analysis. In this regard, the employed specification is augmented with one or two additional variables and is described as follows:

$$i_t = (1-\rho)\alpha + (1-\rho)\beta\pi_{t+n} + (1-\rho)\gamma x_{t+m} + (1-\rho)\delta z_{1,t+k} + (1-\rho)\theta z_{2,t+l} + \rho i_{t-1} + \varepsilon_t \qquad (4)$$

where, for instance, the additional variables, denoted as z^1_{t+k} and z^2_{t+l}, may be represented by a foreign interest rate or a measure of the exchange rate or of the money stock. [17]

To decide on whether the inflation rate shall enter with the current or the one-year-ahead, the following equation is estimated:

$$i_t = (1-\rho)\alpha + (1-\rho)\beta\pi_t + (1-\rho)\gamma x_{t+m} + (1-\rho)\delta\pi_{t+12} + \rho i_{t-1} + \varepsilon_t , \qquad (5)$$

Decision depends on the sign and statistical significance of the involved coefficients, β and δ, as well as on the fit of equations (1) and (2) estimated with n=0, +6 or +12.

3.2 Country results

The estimated reactions functions are presented from Table 3 to Table 13 and are discussed separately for each country. However, in order to directly address the question of whether national policies can be described by relatively homogeneous interest rate rules, we start our analysis by presenting the estimates of the standard Taylor-type interest rate rules within a single table for all the countries. We then progress in our analysis by estimating variants of the standard Taylor rule that include additional variables in order to better capture the actual conduct of the monetary policy followed by each of the EMU-12 member states. As regards the choice of the specifications, it should be noted that it is mainly motivated by the approaches in the existing

[17] Equation (4), and similarly equation (1), can be split into a target rate relation and one capturing interest rate smoothing, i.e. into $i_t^* = \alpha + \beta\pi_{t+n} + \gamma x_{t+m} + \delta z^1_{t+k} + \theta z^2_{t+l}$ and $i_t = (1-\rho)i_t^* + \rho i_{t-1} + \varepsilon_t$.

literature and also, albeit to a lesser extent, by the results of the descriptive analysis of the actual monetary policies of the countries themselves (on this see also Appendix A).

In addition, in Figures B1-B11 presented in Appendix B, the historical interest rate series are plotted together with the derived Taylor-rule (denoted as "target") rates. The choice of using the target Taylor rules instead of the fitted ones is based on the fact that the fitted series follow the actual ones very closely, due to the high degree of interest rate smoothing. Therefore, it is more constructive and informative to use the target series for the comparative analysis and assessment of the goodness of fit of the chosen specification(s), which is a standard approach used in the monetary policy rules literature. The target rules are based on the specification which yields the most plausible estimates in line with both the actual monetary policy followed by the country and the results shown in the literature.

Turning to our analysis, in Table 2 below the estimates at country level of the standard Taylor rule, which includes the interest rate smoothing and a contemporaneous or forward-looking response to the inflation rate, are reported. The adjusted-R-squared, mainly due to the lagged interest rate term, takes noticeably high values (on average around 0.97) indicating in principle a good fit. The interest smoothing coefficient, in accordance with the findings of the relevant literature, takes values from 0.67 to 0.93 and is always statistically significant. The inflation coefficient is positive and significant in all cases, and exceeds unity for Belgium, Greece, Spain, France, Italy, the Netherlands and Finland.[18] On the contrary, the output gap coefficient turns negative in one case (for Portugal) and in two cases (for the Netherlands and Finland) insignificant, indicating its relatively less robust role in monetary policy setting. On the basis of these results, we will now focus on estimating variants of the Taylor rule for each country using the specification (4) introduced in the previous section.

[18] In comparison with the selected specifications, which are contained in Table 3-Table 13 and are in all but one cases augmented with the German interest rate, the inflation coefficient exceeds unity for most countries when the standard Taylor rule specification is considered. This suggests the key role of the German interest rate

Table 2: Standard Taylor rule specification

Country	Specification	α	β	γ	ρ	*(interest rate t-2)* ρ_2	adjR^2	J-stat
Belgium	contemporaneous	**1.53**	**1.68**	**0.97**	**0.89**		**0.95**	**0.66**
		4.08	*6.22*	*4.12*	*56.04*			
Germany	contemporaneous	**2.92**	**0.74**	**0.69**	**0.83**		**0.99**	**1.00**
		27.39	*8.32*	*9.62*	*55.75*			
Greece	forward-looking	**5.62**	**1.38**	**0.45**	**0.67**		**0.95**	**0.99**
	(π_{t+6})	*10.72*	*23.63*	*5.16*	*30.62*			
Spain	contemporaneous	**-1.34**	**1.70**	**1.25**	**0.93**		**0.98**	**0.99**
		-1.23	*14.27*	*2.75*	*64.78*			
France	forward-looking	**3.35**	**1.86**	**0.47**	**1.38**	**-0.50**	**0.95**	**1.00**
	(π_{t+12})	*15.11*	*16.39*	*6.72*	*65.27*	*-22.85*		
Ireland	contemporaneous	**5.95**	**0.28**	**0.08**	**0.68**		**0.96**	**0.99**
		46.98	*3.37*	*5.69*	*33.02*			
Italy	contemporaneous	**-0.73**	**2.20**	**0.87**	**0.75**		**0.95**	**1.00**
		-2.08	*28.60*	*14.11*	*97.50*			
The Netherlands	contemporaneous	**0.95**	**1.38**	**0.02**	**0.93**		**0.99**	**0.75**
		0.97	*2.67*	*0.11*	*69.69*			
Austria	forward-looking	**2.88**	**0.88**	**0.48**	**0.84**		**0.99**	**0.73**
	(π_{t+6})	*22.15*	*8.21*	*8.35*	*27.75*			
Portugal	contemporaneous	**3.71**	**0.83**	**-1.30**	**0.90**	**-0.14**	**0.96**	**1.00**
		22.58	*13.31*	*-27.57*	*35.17*	*-6.75*		
Finland	contemporaneous	**2.16**	**1.01**	**0.00**	**0.85**		**0.97**	**1.00**
		14.98	*10.52*	*0.32*	*88.33*			

Notes:

Coefficients α, β, γ and ρ are introduced in equations (1). The series are described in Appendix C. The numbers in italics denote t-statistics and the column headed 'J-stat' reports the p-value of the null hypothesis that the overidentifying restrictions are valid.

For some countries dummy variables were introduced: for Greece three dummies (1994.04, 1994.05 and 1997.11), for Spain two dummies (multiplicative for 1993.01-08 and additive for 1993.08-1994.11), for Ireland two dummies (1993.01 and 1998.11-12), for Italy two dummies (1996.06 and 1997.09), for Portugal one dummy (1993.01-1995.03) and for Finland two dummies (1993.01-1994.03 and 1994.04-1995.03).

Belgium

According to the analysis carried out in the Appendix A, the policy of the Belgian authorities was heavily affected by the developments in the German economy, especially those related to the exchange rate of the Belgian franc vis-à-vis the German mark. The estimations presented in the present section evaluate and confirm this influence.

In the first place, it shall be noted that the best performing specifications include the current value of the inflation rate. Moreover, independently of the variables considered, the policy rate seems to react considerably to output developments, as the corresponding coefficient is always statistically significant and positive. As for inflation, only the money-augmented specification delivers a point estimate well below unity; however, this specification yields the lowest adjusted-R-squared value. In other words, for the specification with the best fit the inflation coefficient exceeds unity. Regarding the additional variables, the exchange rate and the German interest rate enter significantly and with the correct positive sign. It is also worth noting that the foreign interest rate enters with a value identical to the estimate derived for other countries with similar policies, namely the Netherlands and Austria. The money stock measure enters with the right sign only if the German rate is also included among the regressors.

All in all, the empirical findings are generally in accordance with the characterization of the monetary policy in the country. In Figure B1 of the second appendix, the historical policy rate series is depicted together with the target rate indicated by the specification augmented with the German rate (Q-stat=17.11, 17.86 and 19.05 with a p-value of 0.01, 0.05 and 0.07 for 6, 9 and 12 lags, respectively). The relevance of the underlying rule is visibly demonstrated, although the performance at the end of the sample is a bit less satisfactory.[19] The correlation of the two series increases to 0.93, a value that is noticeably high given that interest rate smoothing is not taken into account in the calculation of the target rate. Finally, Table B1 presents a robustness analysis, where the foreign interest rate-augmented specification is estimated for the various output gap measures introduced earlier. While the derived estimates are qualitatively unaffected, quantitatively some of them change according to the utilized measure.

[19] Although the foreign interest rate-augmented specification yields the second best fit in terms of the adjusted-R-squared, the derived target rate achieves the highest correlation with the historical interest rate series; this is possible since for the calculation of the target rate the (lower) the interest rate smoothing coefficient (compared with the exchange rate augmented specification) does not play any role.

Table 3: Specifications for Belgium (with π_t)

BELGIUM	α	β	γ	ρ	δ	θ	adjR2	J-stat
contemporaneous	**1.53**	**1.68**	**0.97**	**0.89**			**0.95**	**0.66**
	4.08	*6.22*	*4.12*	*56.04*				
Adding:								
German interest rate	**-1.11**	**1.02**	**0.18**	**0.86**	**0.89**		**0.95**	**1.00**
	-8.63	*7.77*	*4.62*	*55.18*	*12.44*			
Exchange rate	**1.27**	**1.88**	**0.93**	**0.89**	**3.11**		**0.97**	**0.77**
	3.24	*7.45*	*4.00*	*77.57*	*3.75*			
Money stock	**3.35**	**0.57**	**0.40**	**0.83**	**-0.83**		**0.93**	**0.78**
	9.51	*2.51*	*2.10*	*45.25*	*-4.66*			
German interest rate	**-0.92**	**1.29**	**0.74**	**0.79**	**0.71**	**0.34**	**0.95**	**1.00**
and money stock	*-26.80*	*32.98*	*41.44*	*27.79*	*46.61*	*18.34*		

Note: Coefficients α, β, γ, δ, θ and ρ are introduced in equations (1) and (4). The series are described in Appendix C. The numbers in italic denote t-statistics and the column headed 'J-stat' reports the p-value of the null hypothesis that the overidentifying restrictions are valid.

Germany

The Bundesbank enjoyed a high degree of independence that was largely retained during the last years before the launch of the euro. In particular, its monetary policy was characterised by the setting of a target for monetary growth that implicitly incorporated goals for inflation (sometimes also referred to as "unavoidable rate of inflation").

Despite numerous studies building on a forward-looking behaviour of the Bundesbank, for the dataset and the sample period of the present analysis the prevailing specification features the current value of the inflation rate. Conversely, if future inflation had been taken into account, its coefficient would have been negative – as shown in the last specification presented in Table 2 where θ corresponds to inflation one-year ahead. In the baseline specification the inflation coefficient does not exceed unity, like in two of the augmented specifications, and the output gap coefficient is positive and ranges from 0.55 to 0.95.

Very interestingly, an increase in the US rate provokes a rise of the German rate and the same happens when the German mark depreciates vis-à-vis the US dollar. As expected, the policy rate is increased when money growth exceeds the announced target value. Including both the money stock and the exchange rate measures confirms the outcome of the individual specifications. It is also noteworthy that in this last specification as well as in the one augmented with the US interest rate the inflation coefficient exceeds unity, suggesting a rise of 3 basis points of the real rate when inflation climbs up by one percentage point.

In Figure B2 the historical Bundesbank's interest rate series is reported together with the target rate implied by the specification featuring both the money stock and the exchange rate measure without allowing for partial adjustment. The specification does not suffer from autocorrelation problems (since the Q-statistics is equal to 15.11, 17.12 and 17.66 with a p-value of 0.02, 0.05 and 0.13 for 6, 9 and 12 lags, respectively). Despite some discrepancies, the target rate tracks the actual pattern of the interest rate and often coincides with the actual series (with the exception of the last 8 months in 1998). Besides, the correlation between the two series is 0.92, thus confirming the relatively good functioning of the Taylor-type rule in the case of Germany.[20] Moreover, the robustness analysis reveals that the parameter estimates remain largely qualitatively similar.

Table 4: Specifications for Germany (with π_t)

GERMANY	α	β	γ	ρ	δ	θ	adjR2	J-stat
contemporaneous	**2.92**	**0.74**	**0.69**	**0.83**			**0.99**	**1.00**
	27.39	*8.32*	*9.62*	*55.75*				
Adding:								
US interest rate	**-1.45**	**1.32**	**0.82**	**0.83**	**0.76**		**0.98**	**0.96**
	-1.80	*12.60*	*6.45*	*54.15*	*5.78*			
Exchange rate (t-3)	**2.82**	**0.93**	**0.90**	**0.75**	**0.09**		**0.99**	**1.00**
	32.28	*13.02*	*16.30*	*29.87*	*6.78*			
Money stock	**3.38**	**0.40**	**0.68**	**0.85**	**0.06**		**0.99**	**1.00**
	13.68	*2.37*	*6.26*	*53.99*	*2.53*			
Money stock and	**2.82**	**1.03**	**0.95**	**0.77**	**0.02**	**0.06**	**0.99**	**1.00**
exchange rate (t-3)	*89.03*	*58.66*	*67.16*	*145.25*	*4.62*	*27.52*		
past (π_{t-12}) and	**2.71**	**0.56**	**0.55**	**0.79**	**0.48**	**-0.21**	**0.99**	**0.96**
future (π_{t+12}) inflation	*24.21*	*7.54*	*9.57*	*56.78*	*7.38*	*-3.17*		

Note: see Table 3.

Greece

Greece is a unique case among the current EMU members, as it was the first member country to join the euro area after the first wave of the eleven founders.[21] Most importantly, in comparison with the rest of the countries, Greece had to cover a longer distance in order to comply with the convergence criteria. Besides, during the period under focus, the Greek monetary

[20] Our findings are in line with Mishkin and Posen (1997) who argued that the German monetary system had key elements of inflation targeting and that monetary policy in the country responded to real output growth and to other economic variables, such as the exchange rate. At the same time, our findings also confirm that money mattered.

[21] Since it adopted the single currency in January 2001, the estimation period is expanded until December 2000.

policy went through two critical episodes. The first critical moment was in May 1994, when the market exerted pressure on the drachma as, following the abolition of the remaining controls scheduled for June, there were expectations of a significant acceleration in its pace of depreciation. Eventually, after drastic policy tightening, the government brought forward capital liberalisation to 16 May 1994 in order to defuse market anticipations. The second critical moment was around mid-1997, in the context of the South-East Asian currency turmoil, when the drachma came again under pressure and the Bank of Greece had to intervene for several months by raising interest rates.[22]

Given the sizeable magnitude of these shocks, the model features three dummy variables denoted as D1994.04, D1994.05 and D1997.11. The inflation coefficient and output gap coefficients are always statistically significant: the former exceeds unity in all but one case, while the latter is always positive. With regard to additional variables, all enter significantly and display reasonable parameter values as expected on the basis of actual developments in the economy. Last but not least, it is worth pointing out that the inclusion of the foreign interest rate (represented by the German interest rate) results in an inflation coefficient below unity, suggesting the critical role of this additional variable.

Table 5: Specifications for Greece (with π_{t+6})

GREECE	α	β	γ	ρ	δ	*dummy 1994.04*	*dummy 1994.05*	*dummy 1997.11*	adjR2	J-stat
forward-looking	**5.62**	**1.38**	**0.45**	**0.67**		**12.44**	**152.53**	**20.22**	**0.95**	**0.99**
(t+6)	*10.72*	*23.63*	*5.16*	*30.62*		*4.21*	*15.28*	*2.73*		
Adding:										
German interest rate	**6.94**	**0.82**	**0.34**	**0.68**	**0.50**	**16.78**	**155.63**	**22.46**	**0.95**	**1.00**
(t-6)	*30.85*	*13.24*	*7.52*	*45.83*	*4.94*	*3.90*	*20.28*	*3.76*		
Exchange rate	**4.35**	**1.50**	**0.32**	**0.69**	**0.20**	**12.34**	**157.69**	**35.70**	**0.94**	**0.99**
(t-1)	*6.80*	*24.07*	*3.23*	*24.16*	*2.79*	*4.13*	*11.28*	*8.25*		
Money stock	**6.13**	**1.31**	**0.56**	**0.67**	**0.51**	**10.18**	**148.44**	**41.42**	**0.95**	**1.00**
(t-1)	*22.72*	*40.27*	*8.58*	*40.60*	*3.97*	*8.08*	*17.96*	*7.81*		

Note: see Table 3. The included dummies equal 1 in the indicated periods and 0 otherwise.

Figure B3 depicts the historical three-month interest rate series together with the target rate series, as calculated by the foreign rate augmented forward-looking specification. This specification delivers one of the highest adjusted-R-squared and its residuals are free of autocorrelation (Q-stat=13.26, 17.02 and 19.65 with a p-value of 0.04, 0.05 and 0.07 for 6, 9 and 12 lags, respectively). Moreover, the corresponding target series shows the highest correlation

[22] For details, see Bank of Greece (2003).

with the historical rate (of 0.82 for the full period and of 0.86 if the observations from April to September 1994 and from October 1997 to May 1998 are excluded). In comparison with other countries, the fit is a bit less satisfactory around the dates of the shocks described earlier, whereas in normal times, the estimated values are not far from the historical series.

Finally, the robustness analysis presented in table B1 shows that the parameter estimates remain qualitatively unaffected by a change in the method used for the evaluation of the output gap.

Spain

Our descriptive analysis in the first Appendix indicates that the Spanish authorities were committed to exchange rate stability and sought to bring down inflation and stimulate employment, principles which are largely confirmed by the empirical findings presented here. More precisely, while the Bank of Spain at the beginning defined an intermediate monetary policy target, it adopted direct inflation targeting in 1995.

The prevailing specifications feature the current value of inflation while economic activity is measured by the annual growth rate of the unemployment rate (with the sign switched around). In addition, two dummies were added in the model as described in equation (3): D1993.01-08 (multiplied with the unemployment measure) covers the period where a huge program to combat rising unemployment was announced as a well as a devaluation of the peseta occurred while D1993.08-1994.11 represents the period of overall tensions for Spain in the ERM.

As shown in the table below, independently of the specification, the inflation coefficient clearly exceeds unity and the unemployment coefficient is always significant and displays the expected positive sign. As for the additional variables, the German rate and the measures of the exchange rate and the money growth enter significantly with a positive sign, thus suggesting that their fluctuations have affected the conduct of monetary policy in Spain.

Taking into account the key indicator role played by the money stock, the selected specification is the one augmented with the monthly growth of M3. This specification yields a good fit with no autocorrelation problems (Q-stat=7.09, 7.66 and 8.38 with a p-value of 0.31, 0.56 and 0.75 for 6, 9 and 12 lags, respectively) and the derived target series achieves the highest correlation with the historical three-month money market interest rate series. As shown in Figure B4, the two series often coincide despite some obvious discrepancies. Their correlation goes up to 0.95 and, from August 1994 onwards, the estimated series reproduces the pattern (and partly the size) of the movement of the actual series in most cases.

Finally, as regards the robustness analysis, the use of any output gap measure based on real GDP data results in considerably different and often not reasonable parameter estimates. This might suggest that unemployment growth had an important role in the monetary policy setting in Spain.

Table 6: Specifications for Spain (with π_t)

SPAIN	α	β	γ	ρ	δ	*dummy 1993.01-08 times unemployment measure*	*dummy 1993.08-1994.11*	adjR2	J-stat
contemporaneous	**-1.34**	**1.70**	**1.25**	**0.93**		**0.66**	**2.12**	**0.98**	**0.99**
	-1.23	*14.27*	*2.75*	*64.78*		*2.83*	*1.67*		
Adding:									
German interest rate	**-2.53**	**1.92**	**0.48**	**0.77**	**0.69**	**0.21**	**-1.38**	**0.98**	**1.00**
	-12.41	*51.77*	*8.79*	*68.03*	*17.63*	*4.75*	*-9.58*		
Exchange rate	**-2.26**	**2.59**	**0.77**	**0.82**	**0.89**	**1.15**	**-0.78**	**0.97**	**0.99**
	-3.89	*23.47*	*4.17*	*43.18*	*5.13*	*7.80*	*-2.05*		
Money stock	**1.75**	**1.25**	**0.19**	**0.79**	**1.50**	**1.03**	**-0.29**	**0.98**	**1.00**
	24.14	*58.00*	*8.15*	*153.13*	*14.89*	*35.20*	*-4.14*		

Note: see Table 3. The included dummies equal 1 in the indicated periods and 0 otherwise.

France

According to the descriptive analysis of the French monetary policy (see Appendix A), one would expect the inflation coefficient to be relatively high. In addition, a significant response of the policy rate either to the German rate or to the exchange rate could be foreseen, as well as a significant role for money stock developments. In this respect, it is worth mentioning that since 1977 the Banque de France was setting targets for monetary growth while in the later period the Banque de France focus on the exchange rate of the French franc vis-à-vis the German mark by steering it within a much narrower band than requited by the ERM rules.

For a better fit, the specifications feature an additional second lag of the interest rate (in addition to the first lag, see equation (2)). Besides, in comparison with the other two specifications, the forward-looking one (with one-year-ahead inflation) clearly prevails in terms of the size and sign of the coefficients. Regarding the response of the policy rate to output developments, it is positive for most augmented specifications. On the contrary, the evidence on the response to inflation is not so clear-cut in terms of its magnitude. In the baseline specification, the corresponding coefficient takes a value significantly above unity, as also in the exchange rate augmented specification. However, the value of the inflation coefficient falls below unity when either the German rate or the money stock measure is included among the regressors, either separately or jointly. In all cases, the various additional variables enter significantly with a positive sign; to be more specific, a one-percentage point rise in the German rate implies almost a one-to-one rise in the French rate. It is also interesting to stress that the inclusion of the German interest rate results in a dramatic fall in the interest rate smoothing parameter.

On the whole, the predictions of the estimations are in line with the overall evidence. Besides, plotting together the historical series and the rule based target rate series casts no doubt on the relatively good performance of the underlying rule, especially between 1993:06 to 1994:12 and from 1996:06 onwards (see Figure B5 in Appendix B). This specification includes both the German rate and the money growth, it yields a high adjusted-R-squared value, does not exhibit any autocorrelation problem (Q-stat=7.09, 10.39 and 11.34 with a p-value of 0.31, 0.32 and 0.50 for 6, 9 and 12 lags, respectively) and the corresponding target rate series is highly correlated (0.94) with the historical series. Last but not least, in the case of France the derived estimates remain qualitatively invariant, independent of the method employed for the evaluation of the output gap.

Table 7: Specifications for France (with π_{t+12})

FRANCE	α	β	γ	ρ	*(interest rate t-2)* $\rho 2$	δ	θ	adjR2	J-stat
forward-looking (t+12)	**3.35**	**1.86**	**0.47**	**1.38**	**-0.50**			**0.95**	**1.00**
	15.11	*16.39*	*6.72*	*65.27*	*-22.85*				
Adding:									
German interest rate	**0.22**	**0.32**	**0.02**	**0.95**	**-0.24**	**0.92**		**0.95**	**1.00**
	6.85	*18.39*	*2.31*	*131.56*	*-38.78*	*123.68*			
Exchange rate (t-3)	**3.40**	**1.60**	**0.39**	**1.09**	**-0.22**	**0.25**		**0.95**	**1.00**
	20.37	*21.02*	*7.57*	*52.86*	*-11.31*	*3.67*			
Money stock	**3.09**	**0.40**	**0.00**	**1.15**	**-0.20**	**0.80**		**0.95**	**1.00**
	24.56	*2.93*	*-0.05*	*63.46*	*-12.82*	*4.68*			
German interest rate and money stock	**-0.08**	**0.52**	**0.04**	**0.91**	**-0.36**	**0.98**	**0.23**	**0.95**	**1.00**
	-4.42	*101.13*	*7.48*	*331.00*	*-104.57*	*430.62*	*38.79*		

Note: see Table 3. The additional smoothing parameter $\rho 2$ corresponds to $\rho_p i_{t-p}$ in equation (2), with p=2.

Ireland

The country analysis signifies the distinctiveness of the Irish case. While Ireland joined the EMS in 1979 and pegged its currency to the pound sterling, nevertheless the punt depreciated during the eighties, also due to the sizeable Ireland's budget imbalances. Irish authorities committed themselves to bring down inflation and the deficit. After the devaluation in 1993, the

Punt remained within the fluctuation bands up to the start of Stage Three of EMU (with a final revaluation taking place in 1998). The empirical analysis presented here also confirms these characteristics.

In particular, a satisfactory fit is obtained when the exchange rate measure enters, as explanatory variable, together with contemporaneous inflation, in the specification with the two foreign (Germany and UK) interest rates. In addition, all the specifications feature two dummies: D1993.01 accounts for the speculative pressures on the Irish punt in the beginning of the period which resulted in the sterling's quitting the EMS in September 1992, while D1998.11-12 represents the revaluation of the punt before the start of the EMU. Despite the discrepancies, the inflation coefficient seems to be positive and in no case it exceeds the unity threshold. The output gap coefficient takes small values that are significant and positive for most specifications. As for the additional variables, and as shown in Table 8, the German and the UK interest rates, as well as the exchange rate, exert substantial influence to monetary policy setting.

Table 8: Specifications for Ireland (with π_t)

IRELAND	α	β	γ	ρ	δ	θ	*dummy 1993.01*	*dummy 1998.11 -12*	adjR2	J-stat
contemporaneous	**5.95**	**0.28**	**0.08**	**0.68**			**27.11**	**-6.28**	**0.95**	**0.99**
	46.98	*3.37*	*5.69*	*33.02*			*22.15*	*-4.07*		
Adding:										
German interest rate	**5.12**	**-0.33**	**0.05**	**0.40**	**0.45**		**18.37**	**-3.12**	**0.98**	**1.00**
	49.46	*-8.48*	*6.88*	*68.80*	*14.58*		*68.62*	*-12.32*		
UK interest rate	**4.12**	**0.13**	**-0.01**	**0.59**	**0.26**		**23.66**	**-3.39**	**0.97**	**0.99**
	13.73	*9.77*	*-0.99*	*318.94*	*6.61*		*292.33*	*-46.21*		
Exchange rate	**5.82**	**0.46**	**0.11**	**0.77**	**0.10**		**33.97**	**-4.84**	**0.92**	**0.99**
	78.42	*6.67*	*7.58*	*60.98*	*10.06*		*23.92*	*-20.57*		
German interest rate and money stock	**3.59**	**-0.23**	**0.02**	**0.38**	**0.57**	**0.40**	**16.99**	**-3.08**	**0.98**	**1.00**
	38.48	*-15.58*	*5.66*	*90.59*	*34.93*	*15.17*	*130.06*	*-58.76*		
German and UK interest rate	**2.34**	**-0.01**	**0.02**	**0.43**	**0.40**	**0.34**	**18.89**	**-2.79**	**0.98**	**1.00**
	31.32	*-1.56*	*4.93*	*582.35*	*50.55*	*25.58*	*730.19*	*-193.65*		

Note: see Table 3. The dummies equal 1 in the indicated periods and 0 otherwise.

In Figure B6 the historical interest rate series and the target rate implied by the specification augmented with the German and the UK interest rate are plotted together. Despite some discrepancies, the target interest rate follows closely the actual series. The choice of the specification is justified by the higher correlation achieved not only in the full estimation period (0.91) but also in various sub-periods. Moreover, the selected specification produces a high adjusted-R-squared and does not suffer from autocorrelation problems (Q-stat=11.11, 12.56 and 14.59 with a p-value of 0.09, 0.18 and 0.27 for 6, 9 and 12 lags, respectively). With regard to the robustness analysis, all different measures of the output gap lead to remarkably similar results.

Italy

Despite being one of the founding members of the European establishment, the Italian economy underwent major imbalances, which made the exploration of monetary policy setting in the country an instructive task. Italy joined the EMS at its establishment in 1979 and until the 90s its monetary policy was aimed at maintaining the exchange rate parity, while M2 was considered an important information variable. The Italian lira exited the ERM in 1992 and only rejoined the ERM in November 1996.

The best specifications of the Taylor rule for Italy are based on the inclusion of the current value of the inflation rate. All specifications feature two dummy variables: D1996.06-1997.09 covers a period where the Italian lira rejoined the EMS, while the dummy D1997.10-1998.08 is related to a period of significant financial market restructuring.

As shown in Table 9, in the baseline specification the inflation coefficient significantly exceeds unity and the output gap coefficient is also relatively high. The outcome is similar for the augmented specifications for some of which the gap coefficient even goes above unity. Regarding the additional variables, the German interest rate and the exchange rate enter with the right sign whereas the money stock displays a counterintuitive negative sign.

Table 9: Specifications for Italy (with π_t)

ITALY	α	β	γ	ρ	δ	*dummy 1996.06 - 1997.09*	*dummy 1997.10 - 1998.08*	adjR2	J-stat
contemporaneous	**-0.73**	**2.20**	**0.87**	**0.75**		**3.79**	**1.11**	**0.96**	**1.00**
	-2.08	*28.60*	*14.11*	*97.50*		*18.41*	*3.08*		
Adding:									
German interest rate	**-0.60**	**1.52**	**1.03**	**0.65**	**0.51**	**3.19**	**0.68**	**0.97**	**1.00**
	-3.66	*43.33*	*34.36*	*65.80*	*29.23*	*41.59*	*3.96*		
Exchange rate	**0.36**	**1.88**	**0.61**	**0.66**	**0.46**	**3.58**	**0.75**	**0.96**	**1.00**
	1.12	*32.02*	*11.76*	*47.06*	*14.90*	*15.43*	*2.64*		
Money stock	**0.07**	**2.33**	**1.19**	**0.78**	**-2.91**	**3.08**	**0.11**	**0.96**	**1.00**
	0.52	*67.90*	*18.88*	*140.24*	*-13.38*	*36.31*	*0.92*		

Note: see Table 3. The included dummies equal 1 in the indicated periods and 0 otherwise.

Among the presented specifications, the one augmented with the German interest rate achieves the best fit and has no autocorrelation problems (Q-stat= 6.50, 7.17, 7.87 with a p-value of 0.37, 0.62 and 0.79 for 6, 9 and 12 lags, respectively). At the same time, the derived target interest rate series attains the highest correlation with the historical interest rate series (0.95). Both series are plotted in Figure B7 and the Taylor-rule implied interest rate is able to reproduce the pattern of the actual series in many instances. Furthermore, to conclude, Table B1 in Appendix B puts illustrates the remarkable robustness of the estimates to the various gap measures.

The Netherlands

The Netherlands is another country whose currency was pegged to the German mark and whose authorities stuck meticulously to the policy of the Bundesbank, in particular under a direct agreement with the German authorities from 1993 onwards. This was considered as being the most effective way to achieve price stability in the medium term.

At the outset, among the various specifications, the one with current inflation delivers the most sensible and robust results. In the baseline specification, the inflation coefficient is significant and exceeds unity, while the output coefficient is not statistically different from zero. The outcome is similar when either the exchange rate or the money stock measure is added to the model; neither of the two variables enters significantly.

Table 10: Specifications for the Netherlands (with π_t)

THE NETHERLANDS	α	B	γ	ρ	δ	θ	adjR2	J-stat
contemporaneous	**0.95**	**1.38**	**0.02**	**0.93**			**0.99**	**0.75**
	0.97	*2.67*	*0.11*	*69.69*				
Adding:								
German interest rate	**-0.22**	**0.42**	**-0.01**	**0.69**	**0.84**		**0.99**	**1.00**
	-4.91	*11.47*	*-1.47*	*34.57*	*59.3*			
Exchange rate	**0.73**	**1.40**	**0.09**	**0.94**	**8.31**		**0.99**	**0.64**
	0.76	*2.82*	*0.43*	*68.46*	*1.17*			
Money stock	**1.60**	**1.11**	**-0.01**	**0.93**	**-0.11**		**0.99**	**0.89**
	2.38	*3.60*	*-0.05*	*90.23*	*-0.18*			
German interest rate and	**0.30**	**0.58**	**-0.02**	**0.81**	**0.60**	**0.06**	**0.99**	**0.99**
money stock	*1.49*	*3.44*	*-0.29*	*15.18*	*5.28*	*0.31*		

Note: see Table 3.

On the other hand, the inclusion of the German interest rate yields different results: although the output coefficient remains insignificant, the inflation coefficient falls below unity and, as expected, the coefficient of the foreign rate enters significantly and with a rather high value. Furthermore, its inclusion causes a remarkable fall in the interest rate smoothing coefficient, but not in the adjusted-R-squared. The joint inclusion of the German rate and the money stock leaves the coefficient of the former qualitatively untouched, while the latter remains insignificant. This is an indication in favour of the German rate augmented specification, which, as all the presented specifications, does not exhibit any autocorrelation problem (Q-stat=10.35, 12.46 and 19.13 with a p-value of 0.11, 0.19 and 0.09 for 6, 9 and 12 lags, respectively).

In conclusion, in the case of the Netherlands the role of the German interest rate is fundamental. The target rate is calculated from the corresponding specification and in Figure B8 is plotted together with the historical interest rate series. The two series display an outstandingly high correlation of 0.99 and obviously co-move. Moreover, the derived estimates are robust to the various output gap measures.

Austria

The exchange rate peg with the German currency also played a major role in Austria. Owing to the achievement of a near-zero interest rate differential, Austria imported Germany's stable nominal and real interest rates. The importance of the German interest rate is indeed confirmed by the findings of the estimated interest rate rules.

To be more specific, the preferred specification contains the inflation rate six months ahead. The corresponding coefficient, even though it enters significantly in almost all cases, remains below unity. As for the coefficient related to the output gap, given the priorities of the Austrian policy, it is not surprising that it once displays the wrong sign.

Regarding the additional variables, the inclusion of the German rate results in a highly significant coefficient, which is very close to the respective one for the Netherlands and Belgium, which are two economies with similar exchange rate policies. Moreover, its inclusion leads to a reduction in the interest rate smoothing coefficient, which is, however, not accompanied by a fall in the explanatory power. In the same vein, the exchange rate enters with a highly significant positive coefficient when introduced as explanatory variable. The same happens also with the money stock measure.

Again, the most relevant specification, i.e. the one including the German rate, is used for the calculation of the target rate (Q-stat=16.82, 17.97 and 18.76 with a p-value of 0.01, 0.04 and 0.09for 6, 9 and 12 lags, respectively). The derived series is depicted in Figure B9 together with the actual three-month interbank interest rate. The correlation goes up to 0.99 and the two series coincide in most instances, thus reflecting the goodness of fit of the underlying rule. A similar result holds in the case where the target rate series is derived from the specification featuring both the German rate and the money stock. Furthermore, the robustness analysis illustrates that the empirical findings do not depend on the specific method used for the evaluation of the output gap.

Table 11: Specifications for Austria (with π_{t+6})

AUSTRIA	α	β	γ	P	δ	θ	adjR2	J-stat
forward-looking	**2.88**	**0.88**	**0.48**	**0.84**			**0.99**	**0.73**
(t+6)	*22.15*	*8.21*	*8.35*	*27.75*				
Adding:								
German interest rate	**0.48**	**0.03**	**-0.12**	**0.65**	**0.88**		**0.99**	**1.00**
	16.26	*2.17*	*-15.87*	*45.55*	*84.85*			
Exchange rate	**3.00**	**0.37**	**0.78**	**0.90**	**18.44**		**0.99**	**0.98**
	27.87	*4.02*	*8.20*	*10.87*	*4.36*			
Money stock	**3.03**	**0.72**	**0.29**	**0.88**	**0.30**		**0.99**	**1.00**
	45.46	*14.12*	*9.13*	*10.30*	*2.86*			
German interest rate and	**0.72**	**0.03**	**0.05**	**0.56**	**0.80**	**0.04**	**0.99**	**1.00**
money stock	*23.26*	*5.51*	*4.50*	*37.7*	*75.85*	*5.36*		

Note: see Table 3.

Portugal

Being small in size and located in the periphery of the European Union, Portugal rarely attracts the attention of monetary policy research. The Portuguese escudo entered the ERM in April 1992 and suffered few realignments up to the mid-nineties, while monetary policy was quite restrictive in trying to bring down inflation. During the second half of the nineties, the main mission of the Banco de Portugal was the achievement of maintaining price stability.

With regard to the empirical analysis, independently of the employed output gap measure, the coefficient of the output gap displays a negative sign, possibly due to poor data quality. The preferred specifications feature the contemporaneous value of the inflation rate, the second lag of the interest rate (in addition to the first, see equation (2)) and a dummy variable (D1993.01-1995.03) corresponding to a period of frequent devaluations of the national currency. In most cases, the inflation coefficient significantly stays below unity, while the policy rate reacts to developments in the German rate (lagged one quarter) and in the exchange rate. Furthermore, the money stock measure seems to affect significantly the monetary policy setting.

The specification including the German interest rate yields one of the highest adjusted-R-squared values (and has no autocorrelation problems: Q-stat= 2.97, 6.16, 23.90 with a p-value of 0.81, 0.72 and 0.02 for 6, 9 and 12 lags, respectively); at the same time, the derived target rate series results in the highest correlation with the historical interest rate series (0.94 in the full period and 0.97 from 1995 till the end). The two series are portrayed in Figure B10 and while for the first years there are considerable divergences, from mid-1995 onwards they move closer together. Last but not least, regarding the robustness analysis with respect to the output gap method, the presented findings remain basically unaltered to a change in the evaluation technique (with the exception of the Band-Pass filter).

Table 12: Specifications for Portugal (with π_t)

PORTUGAL	α	β	γ	ρ_1	(interest rate t-2) ρ_2	δ	θ	dummy 1993.01 - 1995.03	adjR2	J-stat
contemporaneous	**3.71**	**0.83**	**-1.30**	**0.90**	**-0.14**			**2.52**	**0.96**	**1.00**
	22.58	*13.31*	*-27.57*	*35.17*	*-6.75*			*15.00*		
Adding:										
German interest rate (t-3)	**1.41**	**0.48**	**-1.21**	**1.14**	**-0.39**	**0.88**		**1.16**	**0.96**	**1.00**
	10.81	*11.56*	*-90.91*	*84.46*	*-32.36*	*17.48*		*9.34*		
Exchange rate	**4.28**	**0.62**	**-1.33**	**0.94**	**-0.17**	**0.21**		**3.34**	**0.96**	**1.00**
	25.24	*9.54*	*-24.94*	*39.42*	*-7.66*	*2.07*		*17.35*		
Money stock	**0.34**	**2.03**	**-0.77**	**1.59**	**-0.71**	**1.65**		**-0.59**	**0.94**	**1.00**
	0.76	*16.90*	*-9.70*	*72.31*	*-30.50*	*5.05*		*-1.42*		
German interest rate (t-3) and	**0.54**	**0.43**	**-1.21**	**1.16**	**-0.43**	**1.06**	**0.61**	**0.63**	**0.96**	**1.00**
money stock	*2.28*	*8.10*	*-77.23*	*72.31*	*-25.00*	*18.53*	*3.33*	*3.60*		

Note: see Table 3. The included dummies equal 1 in the indicated periods and 0 otherwise and the additional smoothing parameter ρ2 corresponds to $\rho_p i_{t-p}$ in equation (2), with p=2.

Finland

Since February 1993, the Bank of Finland committed itself to an explicit inflation targeting strategy, while the exchange rate of the Finnish markka was allowed to fluctuate up to October 1996 when it joined the ERM. Low inflation was the primary objective of monetary policy, while the maintenance of a large fluctuation band was conducive to both price stability and exchange rate stability.

Due to these developments and, most importantly, to the late participation of its currency in the ERM, Finland is an interesting case worth exploring. In particular, the preferred specifications feature the current value of the inflation rate and two dummy variables (D1993.01-1994.03 and D1994.04- 1995.03), which cover the period before the country's entry in the EU and capture the markka's depreciation in September 1993 and the following swings in the exchange rate. In most of the cases, the inflation coefficient takes a value below unity and the output gap coefficient enters either insignificantly or negatively. The importance of the German rate is put forward by the significance of the corresponding coefficient, the value of which remains large independently of the inclusion of the money stock measure. The inclusion of the exchange rate or the money stock measure also results in positive and significant coefficients.

The specification with the highest adjusted R-squared value (and with no autocorrelation problems, with a Q-stat= 3.45, 4.41, 4.68 with a p-value of 0.75, 0.88 and 0.96, for 6, 9 and 12 lags, respectively) is the one including the foreign rate. Figure B11 depicts the target rate together with the three-month rate, with their correlation standing at 0.96. While early in the sample period some differences can be detected, after the country's entry in the ERM the target series reproduces the evolution of the policy setting more closely. The German rate coefficient is remarkably robust across the different measures of the output gap.

Table 13: Specifications for Finland (with π_t)

FINLAND	α	β	γ	ρ	δ	θ	*dummy 1993.01-1994.03*	*dummy 1994.04-1995.03*	adjR2	J-stat
contemporaneous	**2.16**	**1.01**	**0.00**	**0.85**			**-0.29**	**3.25**	**0.97**	**1.00**
	14.98	*10.52*	*0.32*	*88.33*			*-0.73*	*28.88*		
Adding:										
German interest rate	**-3.58**	**0.14**	**-0.06**	**0.63**	**1.99**		**-4.85**	**-1.74**	**0.98**	**1.00**
	-40.67	*6.35*	*-21.21*	*63.47*	*68.96*		*-46.34*	*-29.38*		
Exchange rate	**0.31**	**2.56**	**-0.10**	**0.89**	**0.65**		**-1.72**	**2.16**	**0.96**	**1.00**
	1.19	*14.15*	*-4.19*	*89.21*	*14.94*		*-3.70*	*7.41*		
Money stock	**2.71**	**0.31**	**-0.01**	**0.86**	**0.28**		**0.21**	**4.43**	**0.97**	**1.00**
	23.70	*3.88*	*-0.84*	*101.04*	*4.71*		*1.10*	*12.83*		
German interest rate and	**-2.35**	**0.23**	**-0.06**	**0.67**	**1.55**	**0.31**	**-3.41**	**-1.00**	**0.98**	**1.00**
money stock	*-34.88*	*10.17*	*-33.60*	*63.28*	*60.79*	*29.33*	*-38.78*	*-18.17*		

Note: see Table 3. The included dummies equal 1 in the indicated periods and 0 otherwise.

The empirical findings of the section are concentrated on the last three figures of Appendix B: Figure B12 shows in descending order the inflation coefficient of each country's preferred specification while Figure B13 does the same for the output gap coefficient. Finally, Figure B14 shows, again in descending order, the German interest rate coefficient either of the preferred specification, if this features the German rate, or the respective coefficient of the German rate augmented specification. Note that together with the point estimates the corresponding standard errors are also reported.

To sum up the findings related to the selected specifications, for Belgium, the Netherlands and Austria, or, in other words, for the countries whose national currency was pegged to the German mark, the preferred specification is the one augmented with the German rate. Interestingly, the value of the corresponding coefficient hardly varies across these countries. Not surprisingly, the German rate estimate takes a similar value also for France. As for the inflation and output gap coefficients, in most cases they take plausible values indicating some compatibility of domestic and foreign objectives.

Moving to southern Europe, on the one hand considering the case of Italy, Spain and, to some extent, Greece, these countries display some similarities in terms of Taylor rule, as the values of the inflation coefficient is high and the significance of the response to developments in output is unambiguous. On the other hand, for Portugal (but also for northern countries such as Ireland and Finland), the value of the inflation coefficient stays below unity, while the output coefficient either takes small values or turns negative or insignificant. This notwithstanding, for all six of them the German rate plays a significant role and even enters in the preferred specification, with the exception of Spain. Bearing these results in mind, a possible conclusion is that in the case of Greece, Portugal, Finland and Ireland the foreign goals prevail over domestic ones.

Finally, due to its leading role, Germany has to be seen as a special case. The preferred specification confirms the Bundesbank's aversion to inflation and substantiates the pronounced and traditional role of monetary targeting.

All in all, to give a brief reply to the questions posed in the introduction, the findings of the present analysis do not support the presence of a common rule across the examined economies. Despite the similarities emphasized earlier, each country's rule turns out to be distinct. Besides, the estimated parameters display (with a few exceptions related to the gap variable) the expected sign and size and substantiate empirically the official statements regarding the objectives and methods of monetary policy setting. Moreover, in every case, the prevailing specification differs substantially from the simple Taylor rule (with interest rate smoothing) mainly due to the pronounced significance of the German rate.[23] In this context, the presented results provide striking evidence in favor of the 'German leadership hypothesis' (see Fratianni

[23] Regarding the fit of the baseline simple Taylor rule with interest rate smoothing, the correlation of the derived target rate series is substantially lower than the one achieved by the selected specification: 0.52, 0.92, 0.81, 0.84, 0.78, 0.83, 0.86, 0.27, 0.85 and 0.81 for Belgium, Germany, Greece, Spain, France, Ireland, Italy, the Netherlands, Austria and Portugal respectively. In addition, restricting the estimated coefficients to the values originally suggested by Taylor (1993) always yields strong rejections- no matter the formulation of the non-linear restrictions.

and Von Hagen (1990a, 1990b)) during a period where it is particularly likely to be strongly observed.

To close the section, the correlation of the target rate series derived by each country's best specification with the historical rates generally exceeds 92% and it only drops to 86% in the case of Greece when the period of turbulence is included. In the context of the simple-rules literature and in light of our assumptions regarding comparability and simplicity, the estimated rules clearly demonstrate a satisfactory fit, despite some discrepancies witnessed for certain countries during parts of the sample period. In addition, the presented estimates remain basically unaltered to a change in the output gap evaluation technique. However, this analysis is subject to the usual caveats which surround the use of Taylor rules in assessing monetary policies. First, it cannot be assumed that all relevant information needed to conduct monetary policy can be encapsulated in the restricted set of variables which are usually included in the rule. Many other variables, such as credit aggregates, private sector expectations, stock valuations, fiscal indicators, variations in international commodity prices and wage agreements may be highly indicative of macroeconomic developments and thus help to interpret the current economic situation.

Second, uncertainty characterises the weights to be attributed to inflation and the output gap as they have to be estimated and, therefore, they are both method- and sample-dependent. Moreover, different options exist for estimating the output gap, while the choice of the consumer price index can also be subject of debate.

Third, different sources of shocks call for very different policy responses. The need for monetary policy to react on the occasion of incoming new evidence may depend on whether shocks arise from the supply or demand side of the economy and whether they represent temporary disturbances to an unchanged underlying structure or a lasting alteration of economic parameters. Taylor rules, in restricting the information which trigger policy decisions, are not a reliable guide for policy from this perspective. Therefore, the assumption that the decision-making body of any central bank could base its decisions exclusively on the information content of Taylor rule variables is a pure simplification.[24] Furthermore, our specific analysis may also be influenced by the fact that most countries were undergoing significant changes, in the run-up to EMU.

Finally, it is a well-documented fact in the recent literature that Taylor rules leave the real economy without an anchor. As shown by a number of authors, Taylor rules can themselves be a

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24 In the words of Orphanides (2001), "*... Retrospectively, the 'appropriate' policy setting for a particular quarter may appear different with subsequent renditions of the data necessary to evaluate the rule for that quarter...*", p. 965.

source of real economic instability.[25] To sum up, using the words of Orphanides "*[The] historical analysis suggests that the Taylor rule appears to serve as a useful organising device for interpreting past policy decisions and mistakes, but adoption of the Taylor-rule framework for policy analysis is not insurance that past policy mistakes would not have occurred.*"[26]

4 Concluding remarks

The analysis of the previous sections offers a meticulous description of the monetary policy setting in Belgium, Germany, Greece, Spain, France, Ireland, Italy, the Netherlands, Austria, Portugal and Finland and reveals the similarities and differences in the conduct of monetary policy across current EMU countries during the 1993-98 period. In particular, it has been shown that each country's rule is distinctive, while the importance of the German rate is in all cases undisputable. Notwithstanding the poor fit of the simple Taylor rule (featuring interest rate smoothing), the target rate series derived from the appropriately augmented selected specifications achieves a considerable correlation with each country's historical interest rate series. Moreover, the estimated parameters take plausible values in almost all cases, establishing in this way the merit and usefulness of the exercise undertaken here.

Of course, it can be argued that the results could be subject to the Lucas critique. While the latter cannot be rejected at a theoretical level (since reduced-from models are not invariant to policy-induced structural changes), its empirical relevance is subject to dispute in the literature. More recently, studies using simulated data generated for expectational models with historical policy rules seem to have found little evidence for the Lucas critique to be at work (Rudebusch 2005). In line with this result, it might be argued, that given the fact that our estimations end in 1998 would speak against a strong regime-shift effect to be at work. Having said this, however, an empirical proof remains to be done and would have to be the topic of a separate follow-up paper.

[25] These pathologies can even occur, when a stabilising Taylor rule (i.e. a rule characterised by an inflation response higher than unity) is followed. Christiano and Rostagno (2001) have shown that a monetary monitoring (i.e. a policy that includes a commitment to switch to a money growth target in the event that the economy slips into deflation) might be helpful in such a case.

[26] Orphanides (2003), p. 984.

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Appendix A: Description of monetary policies pursued in the EMU member states

The Maastricht Treaty, signed in December 1991, defined three stages in the process towards monetary union: in the first stage, which started in July 1990, the EMS countries abolished capital controls while exchange rate realignments were possible and the cooperation among the involved national central banks started strengthening. The second stage started in January 1994 and related to the transfer of monetary and economic policy (exchange rate policy included) to the European institutions while in the third stage the starting date of which was agreed to be January 1999, the ECB started its operations and the single currency was launched.[27]

The period 1993-1998 examined in the present paper coincides with the transition to the monetary union. This transition was made conditional on a number of convergence criteria, also known as the Maastricht criteria. More specifically, these state that (1) the average rate of inflation should not be more than 1.5% higher than the average of the three lowest inflation rates in the EMS; (2) the average nominal long-term interest rate should not exceed by more than 2% the rates of the three best performing member states; (3) the currency should not devalue over a period of two years prior to the start of the third stage; and (4) the ratio of the budget deficit to GDP should not exceed 3% and the ratio of government debt to GDP should not exceed 60%.[28] The rest of the present Appendix offers a description of the main monetary policy developments in all EMU member countries both before and during the second stage.

While during its first four years (1979-83), the ERM more closely resembled a crawling peg rather than a fixed exchange rate regime (realignments took place almost every year during this first period, see the table below), over time the system evolved towards a more rigid regime, and the years from 1987 up to the 1992-93 crises witnessed no adjustment at all. In the same vein, the 1993-1998 period coincides also with a period of speculative peace within the EMS. After the turbulences in 1992 and early 1993, the intervention margins were widened to $\pm$15% around the bilateral central rate. In this way, over short horizons, the central banks had more autonomy in acting as wider exchange rate fluctuations were tolerated, even though over longer horizons the commitment to a narrow target still applied, mainly due to the convergence requirements. Interestingly, after the August 1993 adjustment, ERM exchange rates never came close to the

[27] According to the Treaty, the transition to the third stage was to take place in 1997 if a majority of member countries fulfilled the criteria. But, if by the end of 1997, the starting date of the third stage had not been set, it was to start on 1 January 1999 with those countries which had achieved the necessary degree of convergence.

[28] For more details (also about the EMS) and a discussion on the topic, see De Grauwe (2003).

limits of their wider bands, except for a couple of occasions, mainly in early 1995 when the Spanish and Portuguese currencies were realigned. This speculative pressure soothing was assisted and sustained by the gradual macroeconomic convergence among EU countries. Besides, as argued by Bartolini and Prati (1998), the resilience (and success) of the system can also be attributed to the intervention scheme, which, due to the wider bands, enjoyed additional freedom.[29]

Table 14 Realignments in the EMS

(percentage changes of central rates against currencies of other participating countries)

With effect from	D-marks (DEM)	French francs (FRF)	Dutch guilders (NLG)	Belgian francs (BEF)	Italian lire (ITL)	Irish pounds (IEP)	Spanish pesetas (ESP)	Pounds sterling (GBP)	Portuguese escudos (PTE)	Austrian schillings (ATS)	Finnish markka (FIM)	Greek drachmas (GRD)	Danish kroner (DKK)
24/09/1979	+ 5.0	+ 3.0	+ 3.0	+ 3.0	+ 3.0	+ 3.0	•	•	•	•	•	•	-
30/11/1979	+ 5.0	+ 5.0	+ 5.0	+ 5.0	+ 5.0	+ 5.0	•	•	•	•	•	•	-
23/03/1981	-	-	-	-	- 6.0	-	•	•	•	•	•	•	-
05/10/1981	+ 5.5	- 3.0	+ 5.5	-	- 3.0	-	•	•	•	•	•	•	-
22/02/1982	-	-	-	- 8.5	-	-	•	•	•	•	•	•	- 3.0
14/06/1982	+ 4.25	- 5.75	+ 4.25	-	- 2.75	-	•	•	•	•	•	•	-
21/03/1983[2)]	+ 5.5	- 2.5	+ 3.5	+ 1.5	- 2.5	- 3.5	•	•	•	•	•	•	+ 2.5
22/07/1985	+ 2.0	+ 2.0	+ 2.0	+ 2.0	- 6.0	+ 2.0	•	•	•	•	•	•	+ 2.0
07/04/1986	+ 3.0	- 3.0	+ 3.0	+ 1.0	-	-	•	•	•	•	•	•	+ 1.0
04/08/1986	-	-	-	-	-	- 8.0	•	•	•	•	•	•	-
12/01/1987	+ 3.0	-	+ 3.0	+ 2.0	-	-	•	•	•	•	•	•	-
08/01/1990	-	-	-	-	3)	-	-	•	•	•	•	•	-
14/09/1992	+ 3.5	+ 3.5	+ 3.5	+ 3.5	- 3.5	+ 3.5	+ 3.5	+ 3.5	+ 3.5	•	•	•	+ 3.5
17/09/1992	-	-	-	-	•	-	- 5.0	•	-	•	•	•	-
23/11/1992	-	-	-	-	•	-	- 6.0	•	- 6.0	•	•	•	-
01/02/1993	-	-	-	-	•	- 10.0	-	•	-	•	•	•	-
14/05/1993	-	-	-	-	•	-	- 8.0	•	- 6.5	•	•	•	-
06/03/1995	-	-	-	-	•	-	- 7.0	•	- 3.5	-	•	•	-
16/03/1998	-	-	-	-	-	+ 3.0	-	•	-	-	-	-	-

Source: Denmark's National Bank (http://www.nationalbanken.dk)

Note: The European Monetary System (EMS) was established on 13 March 1979 and was abolished on 1 January 1999 on the adoption of the euro by 11 EU member states.

1) Corresponding to the official wording of the press communiqués issued.

2) As the sterling rate rose strongly after the realignment on 21 March 1983, it was decided in May 1983 to carry out a formal EMS realignment designed to place sterling in the ECU at the market rate of 13 May 1983 at the same time as the agricultural price agreement. Bilateral parities and intervention rates remained unchanged.

3) On 8 January 1990 the fluctuation band for the Italian lira, was reduced from +/-6 per cent to +/-2¼ per cent around the bilateral central rates. In connection with the narrowing of the fluctuation band the intervention rates for the lira vis-à-vis the other ERM currencies were adjusted. The adjustment was made so that the lower limit for the lira vis-à-vis the other currencies remained unchanged whereas the upper limit was adjusted.

[29] For an extensive discussion on the implications of the EMS design, see Begg et al. (1997).

As background information to our analysis, the present appendix provides a brief descriptive overview on the institutional and monetary policy situation in the countries subject to our investigation. Such an exercise might serve different purposes. First, it might illustrate, which kind of shocks each country was subject to. Second, it might highlight the modifications in the ERM rules that have occurred over time. Third, it might demonstrate that — at least for some periods — other variables such as, for instance, monetary aggregates might have played a role as additional information variables in interest rate decisions.

Belgium, at the beginning of the 1980s, was facing difficult economic conditions and serious budgetary problems. The February 1982 devaluation of 8.5% signalled a reorientation of the economic policy that consisted of a cut in real wages and a budgetary tightening. In addition, monetary policy was designed to maintain a stable exchange rate by keeping the Belgian franc well within the band and close to the German mark, to which it was finally pegged in June 1990. In the 1993 crisis, the National Bank of Belgium, assisted by the government's strategy of fiscal consolidation, defended the exchange rate by all possible means and, once the scope of speculative attacks narrowed in the beginning of 1994, the franc recovered. However, it is worth stressing that, as a result of the very high debt-to-GDP ratio, the real interest rate remained high throughout the ERM period.[30]

Germany was one of the founding members of the EMS and, given the asymmetric nature of the system, soon became the leader economy mainly due to the German Central Bank's (the Bundesbank's) commitment to internal price stability. According to its statute, the Bundesbank was bound to 'safeguard the currency' and since 1974, by means of a procedure that – with the exception of some small and mostly technical changes — remained in principle unchanged until 1999, was setting targets for monetary growth that implicitly incorporated goals for inflation (sometimes also referred to as "unavoidable rate of inflation"). The performance of the Bundesbank was very successful as both the level and the variance of the German inflation were relatively low by international standards. As regards the economic developments, it should be noted that within the EMS the German mark was revalued several times although, vis-à-vis the US dollar, it experienced a steady depreciation after the oil shocks and until 1985. In view of this, the Bundesbank was insistently raising the interest rate, a policy that brought about a contraction in real activity — aggravated also by supply-side problems — and a major drop in inflation. The exchange rate of the German mark vis-à-vis the US dollar started appreciating and following the looser monetary policy, a robust output growth materialized and continued through the German unification process. However, this expansion, together with the consequences of the reunification,

[30] This discussion is based on Maes and Quaglia (2003) and Muscatelli, Tirelli and Trecroci (2003).

led inflation to accelerate and the Bundesbank to tighten its key rates. This move triggered the EMS crisis in 1992-93 and caused a recession in the German economy. In return, by 1998 inflation averaged less than 1 percent and the Bundesbank became one of the 11 central banks of the euro-system.[31]

Greece joined the European Community in 1981 and was the last country to enter the ERM in March 1998. In 1989, following a decade of large budget and current account deficits and exceptionally high inflation above the one in the other European countries, the Bank of Greece set out the so-called "hard drachma" policy in an attempt to stabilise the economy. This policy involved fiscal consolidation and an exchange rate peg, according to which the drachma was allowed to depreciate relative to the ECU by less than the full inflation differential. The bank continued announcing monetary targets − within the limits set by the government's overall economic policy − while the exchange rate progressively turned into the primary nominal anchor of the economy. However, the drachma continued to depreciate at a fast rate and inflation, despite its decline since 1990, was high in 1994. On the fiscal side, the wage indexation was abolished in 1990 and an income policy was put into effect. Despite the partial success of these measures, the debt-to-GDP ratio continued to climb and the GDP growth was low, only resuming in 1994. In 1995, the Bank of Greece tightened further the "hard drachma" policy: for the first time a specific exchange rate target was announced and a 3% depreciation limit against the ECU was set. At the same time, the central bank was monitoring monetary and credit aggregates as indicators. By 1997, inflation had been more than halved and in 1998, following the participation in the ERM, the bank expressed its intention to achieve price stability by the end of 1999 and to uphold a stable exchange rate as an intermediate target. Finally, Greece became the twelfth member of the EMU in January 2001.[32]

Spain accessed the European Community in 1986 and its Central Bank became increasingly concerned about the course of the exchange rate. With the intermediate monetary policy target being M3 or a broader aggregate (the so-called 'liquid assets held by the private sector' or ALP), the bank began to monitor the bilateral nominal exchange rate against the German mark very closely. The interventions were aimed at containing the upward trend of the peseta that appreciated by about 3% against the German mark over 1987, thus generating deviations in the monetary targets while capital controls were introduced to curb speculative flows. When the peseta joined the EMS in June 1989, the exchange rate commitment formalised

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[31] The main sources of this discussion are Baltensperger (1999) and Neumann and von Hagen (1993).

[32] The discussion on the Greek experience draws on Detragiache and Hamann (1997), Mourmouras and Arghyrou (2000), Garganas and Tavlas (2001) and Papaspyrou (2004).

an attempt to achieve credibility. The entry was accompanied by a fiscal consolidation plan while the domestic economy was expanding vigorously and, although ALP growth targets were maintained, the exchange commitment ruled out any reaction to deviations from the target. During the first three ERM years, the peseta remained in the upper range of the ±6% band. In 1992, after the full relaxation of the capital controls, the Spanish authorities proceeded by a series of devaluations (of 5% in September, 6% in November and 8% in May 1993) before the fluctuation bands were broadened. In the meantime, the domestic macroeconomic situation was difficult not only with respect to the inflation rate but, above all, with respect to the exceptionally high unemployment level. To provide the economy with a nominal anchor, the Bank of Spain, after the June 1994 autonomy law, adopted direct inflation targeting in 1995.[33] Short-term and long-term interest rates gradually began to decline, inflation dropped and Spain became one of the founding members of the EMU.

France participated in the EMS continuously since its creation in March 1979. Its policy relied on two fundamental intermediate objectives: strict adherence to the ERM and money supply growth targets. In particular, since 1977 the Central Bank of France was setting targets for monetary growth: for M2 from 1988 till 1990 and for M3 from 1990 onwards. These targets were, however, often overshot. During the period 1981-83, three successive devaluations took place but interest rates were not increased to defend the franc; instead sizeable capital controls were imposed. At the same time, the government attempted to boost output and employment by means of an expansionary fiscal policy. The ensuing inflation outburst and the speculative attacks against the French franc forced a quick policy reversal. Thus, in the fall of 1984, the country entered a disinflation phase and the government announced that monetary authorities would rely more heavily on interest rate changes while financial deregulation would take effect.[34] Two more realignments took place before the inflation differential with Germany narrowed and a positive real interest rate differential in favour of the franc arose. In January 1990, foreign capital movements were completely liberalised and both fiscal and monetary policies were geared towards reputation building. The realignments ceased, the exchange rate was steered within a much narrower band than required by the ERM rules and the central parity was never revised.[35]

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[33] This discussion builds on Ayuso and Escriva (1998), Gutierez (1998) and Almeida and Goodhart (1998); the latter note that ALP growth was a key indicator, the money market overnight rate the operational target and the 10-day repo rate the key variable signalling policy changes.

[34] Melitz (1993) stresses that the changeover to conservative monetary policies in France took place without any move towards central bank independence; it was rather based on a consensus between the government, the Treasury and the Bank of France.

[35] The sources of this review of economic policy in France are Melitz (1993) and Muscatelli, Tirelli and Trecroci (2003).

When **Ireland** joined the EMS in 1979 its currency was pegged to the pound sterling. The peg was not an effective nominal anchor, however, and the punt depreciated in 1979, 1981 and 1982, also due to the sizeable Ireland's budget imbalances. At this time, political consensus emerged around the need for macroeconomic stabilisation. After the depreciations in the period 1983-84, the currency remained stable for two years as the monetary stance became tighter with real interest rate turning from negative to positive and remaining high. These policies succeeded in bringing down the inflation rate and the overall deficit, but at the same time brought about low GDP growth which, together with the high interest rates, resulted in a growing debt-to-GDP ratio. In 1986, expenditure cuts initiated a phase of fiscal adjustment while, in August of the same year, the substantial losses of the sterling triggered a devaluation of the Irish pound by 8% relative to the ECU. The devaluation did not lead to inflation increases, but instead to labour cost competitiveness improvement and GDP growth acceleration through higher factor productivity and increased employment. The current account moved to near balance and started registering surpluses in 1990. After a temporary slowdown in 1991-93, economic expansion continued from 1994 onwards. The revaluation of the punt in 1998 was the last official realignment before the formation of the EMU, one of the founding members of which is Ireland.[36]

Italy joined the EMS at its establishment in 1979. Between 1981 and 1985, a flexible exchange rate policy was pursued and the Italian lira was realigned on five occasions. In 1981, the Bank of Italy ceased financing the budget deficit and in 1984 announced its first official target for M2, while capital controls provided room for monetary targeting in the short run. During this period, in spite of the loose exchange rate anchor and thanks to the moderate wage growth, most of the disinflation was achieved. As for the current account deficit, it improved gradually and in 1986 it turned to surplus. During the period 1987-92, the lira remained broadly stable within the EMS and its credibility was enhanced by the adoption of the narrower ±2.25% bands in January 1990. In the same spirit, later in 1990 Italy removed completely the capital controls. However, the loose fiscal policy stance and the mounting public debt cast doubts on the controllability of inflation; indeed, throughout the period, the pace of disinflation slowed down as neither the fiscal adjustment nor the income policy were sufficiently tight. At the same time, monetary policy − operated mainly through market-based instruments − remained tight.[37] In 1992, the Bank of Italy was entrusted with the setting of the discount rate − as a boost in its independence − and during

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[36] The discussion builds on Detragiache and Hamann (1997).

[37] According to Visco (1995), until the early 1990s, monetary policy aimed at maintaining the exchange rate parity while M2 was considered as an important information variable. Even when the signal was plain, the monetary target was pursued with certain flexibility so as to account for portfolio shifts and other financial innovations. The government established the inflation targets and the Bank of Italy aligned monetary policy accordingly.

the ‘hard ERM’ period it defended the parity. However, there was growing scepticism concerning the compatibility of the Italian public finances with the Maastricht Treaty requirements; this disbelief was confirmed by the dramatic exit of the lira from the ERM in September 1992 and the subsequent depreciations during the following two years. The strengthened fiscal adjustment and the wage moderation prevented the effects of these depreciations being passed on to prices. In the following two years, the lira continued to depreciate considerably. In November 1996, Italy rejoined the ERM and in 1998 the Bank of Italy became one the 11 founding members of the EMU.[38]

As for **the Netherlands**, after its devaluation in 1983, the Dutch guilder was linked to the German mark at an unchanged parity, first solely within the ERM framework, and since 1993 also under a bilateral agreement between the two authorities.[39] In the same context, during the 1980s, the Netherlands gradually moved from a combination of monetary and exchange rate targeting to a full reliance on the peg to the mark as the benchmark for monetary policy. Given the high trade share with Germany and in light of the soundness of the German monetary policy, the peg was considered the most effective and efficient way to achieve price stability in the medium term.[40]

After the accession to the EU in 1986, **Portugal** experienced a period of fast economic growth that reduced the income gap with the rest of Europe. In October 1990, the escudo was pegged to a basket of European currencies and monetary policy became more restrictive, while the Central Bank of Portugal separated from the Treasury. In the following two years, the escudo remained stable and even appreciated in nominal effective terms. In April 1992, the currency entered the ERM with a fluctuation band of ±6% and in December, once capital controls were completely abolished, was made fully convertible. Affected by the widespread turmoil on European foreign exchange markets, the central parity of the escudo was devalued in November 1992, May 1993 and March 1995. Nevertheless, inflation continued its steady decline while a deep recession and a deterioration of the country’s fiscal position materialised in 1993. From 1995 onwards, price stability emerged as the main mission of the Central Bank − the autonomy of

[38] The sources of this analysis are Detragiache and Hamann (1997), Visco (1995) and Muscatelli, Tirelli and Trecroci (2003).

[39] According to this agreement, the guilder should not deviate more than 2.25% around its mark parity and as noted in Hilbers (1998). The Minister of Finance was responsible for the choice of the exchange rate regime and the adjustments of the parity, whereas the Central Bank of the Netherlands was responsible for the daily management of the exchange rate within this regime.

[40] This discussion is based mainly on Hilbers (1998).

which regarding the management of monetary policy was enhanced − and Portugal managed to be among the first members of the EMU.[41]

Austria entered the European Union in 1995 and, therefore, did not formally participate in the EMS. However, the Austrian schilling was pegged to the German mark and showed virtually no fluctuations after its appreciation (of 4.5% in total) between September 1979 and late 1980.[42] After the formal application for membership in the European Community, overall policy aimed at complying with the community's policies. Safeguarding the exchange rate peg was a central feature of the pursued policy, while a program of gradual consolidation curbed the rising budget deficits. The liberalisation of the capital controls started in 1986 and was completed in November 1991. Regarding monetary policy, during the 1980s there was a move towards market-oriented monetary policy instruments and, judging from the institutional set-up, the Austrian central bank enjoyed full functional independence. Even though the responsibility for the exchange rate policy was shared with the government, monetary policy was the exclusive competence of the central bank. The primary objective was maintaining the value of the currency both regarding its domestic purchasing power as well as its parity with some foreign currencies. Owing to the establishment of a credible peg to the German mark and the achievement of near zero interest rate differentials, Austria imported Germany's stable real and nominal interest rates.[43] In this way, the policy dilemma − protection of the exchange rate goal at the cost of larger interest rate fluctuations − did not materialise in Austria.

The recession of the early 1990s left a problematic legacy for economic policy in **Finland.** In November 1991, the Finnish markka devalued by 12% against the ECU basket, and, in September 1992, was allowed to float.[44] Initially, during this floating phase, the currency depreciated sharply (17% up to January 1993) and interest rates, albeit declining, remained high. In the beginning of 1993, aggregate output fell by 14%, the unemployment increased fivefold and the ratio of public sector debt-to-GDP increased fourfold compared with three years earlier. Against this background, in February 1993 the Bank of Finland committed itself to an explicit inflation target, i.e. to the stabilisation of the inflation rate at 2% by 1995.[45] In the summer of

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[41] The information on the Portuguese economy comes from Detragiache and Hamann (1997).

[42] The August 1993 speculative attack against the schilling was successfully countered by means of moderate intervention volumes and short-term interest rate rises.

[43] See Gnan (1994) for further information regarding Austria.

[44] See Pikkarainen et al. (1997) and Akerholm and Brunila (1995) for further information.

[45] According to Pikkarainen et al. (1997), the Bank of Finland adopted this target so as to offer the economy a transparent nominal anchor especially after the changeover to a floating exchange rate regime. Akerholm and Brunila (1995) note that the Bank had the sole responsibility for announcing such a target and enjoys a high degree of independence by international standards. In addition, as reported in Almeida and Goodhart (1998), the evaluation of future inflation was based on wage, exchange rate and money

1993, the Finnish economy began to pull out of the recession largely due to the rapid export growth. The markka's real exchange rate strengthened without an acceleration of inflation, the nominal exchange rate remained stable (after a strong appreciation of 16% from March 1993 to October 1994) and both the nominal and real interest rates declined. Finland joined the European Union in 1995, and the markka joined the ERM in October 1996. In this context, low inflation remained the primary objective of monetary policy, while the large exchange rate fluctuation band prevented it from speculation and served as a buffer to a possible conflict between the price stability objective and the maintenance of the central rate.

aggregates developments and, from October 1995, the central bank also took into account inflation forecast 6 to 8 quarters ahead. Finally, after the revision of the intervention procedure, in autumn 1994, the key variable for signalling policy change was the one-month tender rate.

Appendix B: Additional figures and tables

Figure B1

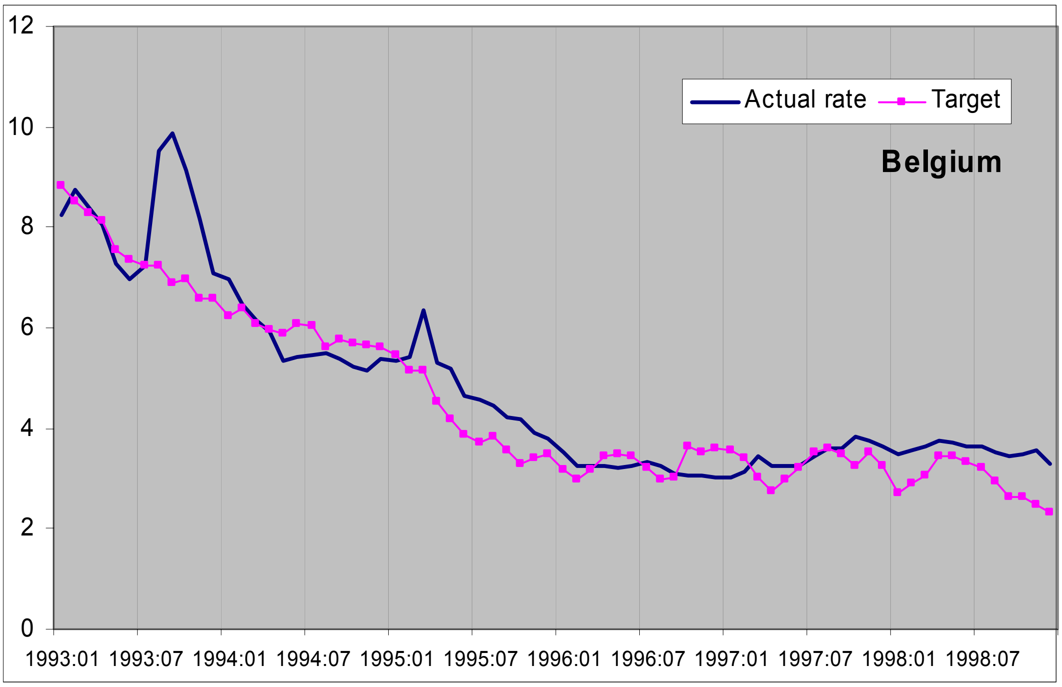


Figure B2

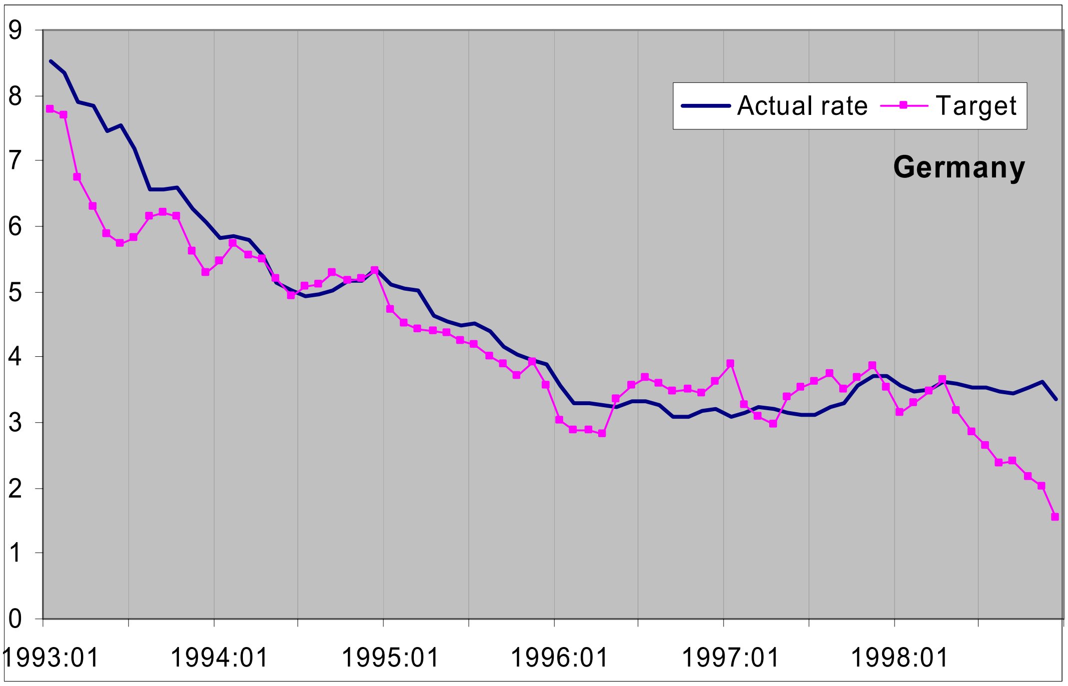


Figure B3

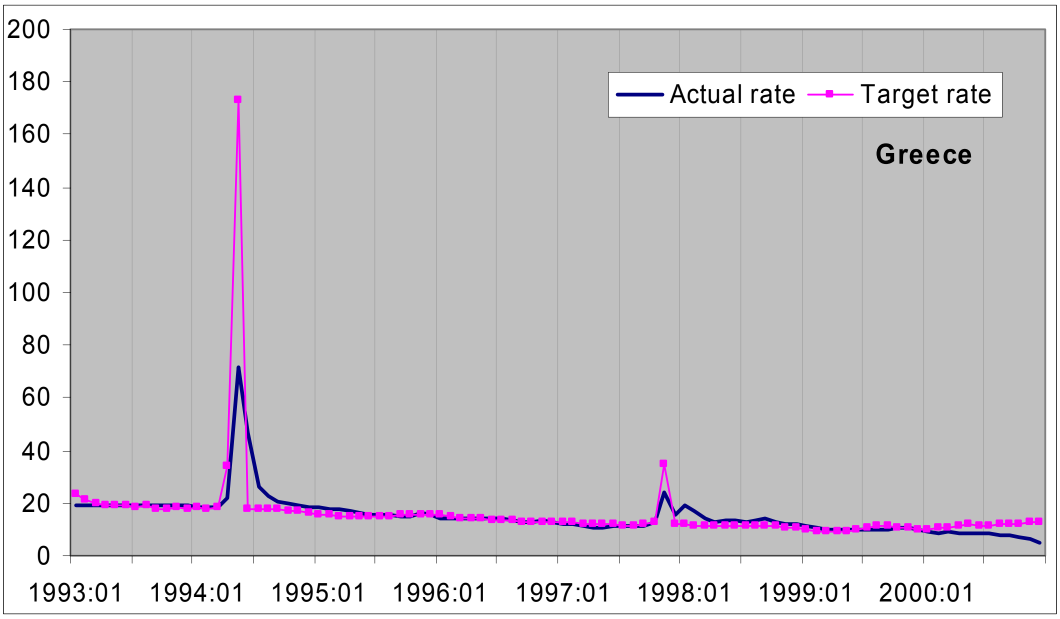


Figure B4

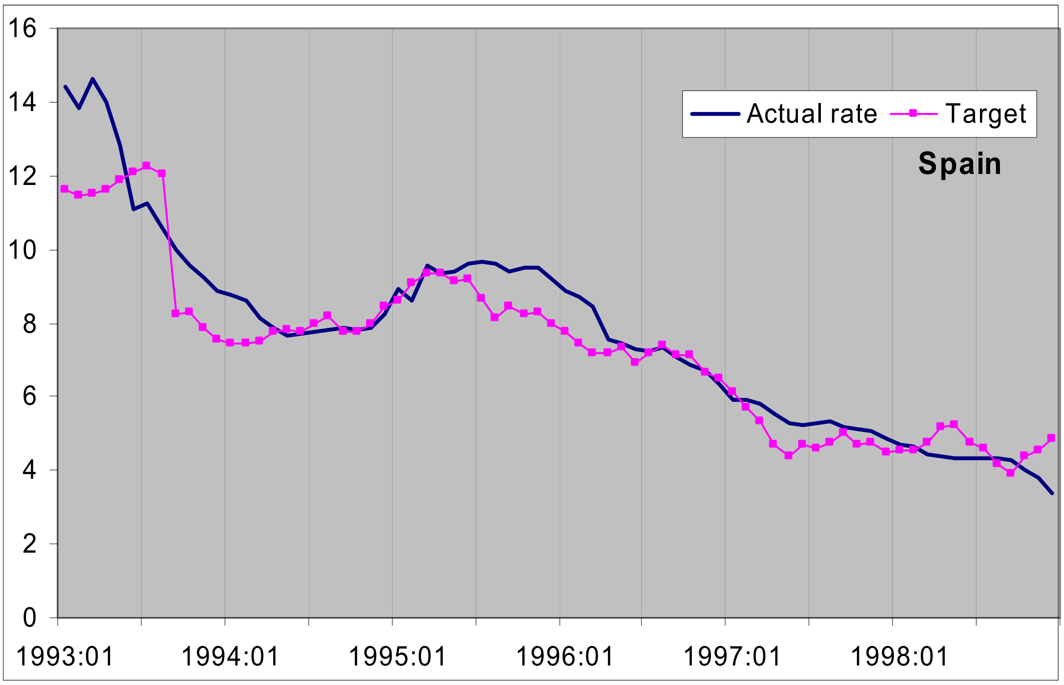


Figure B5

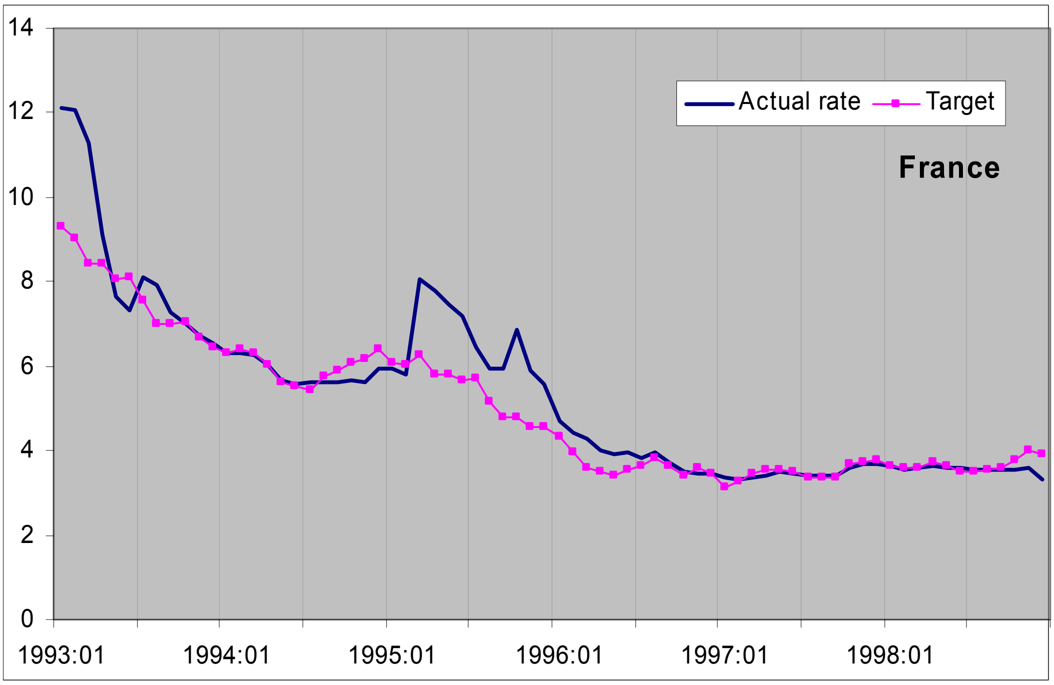


Figure B6

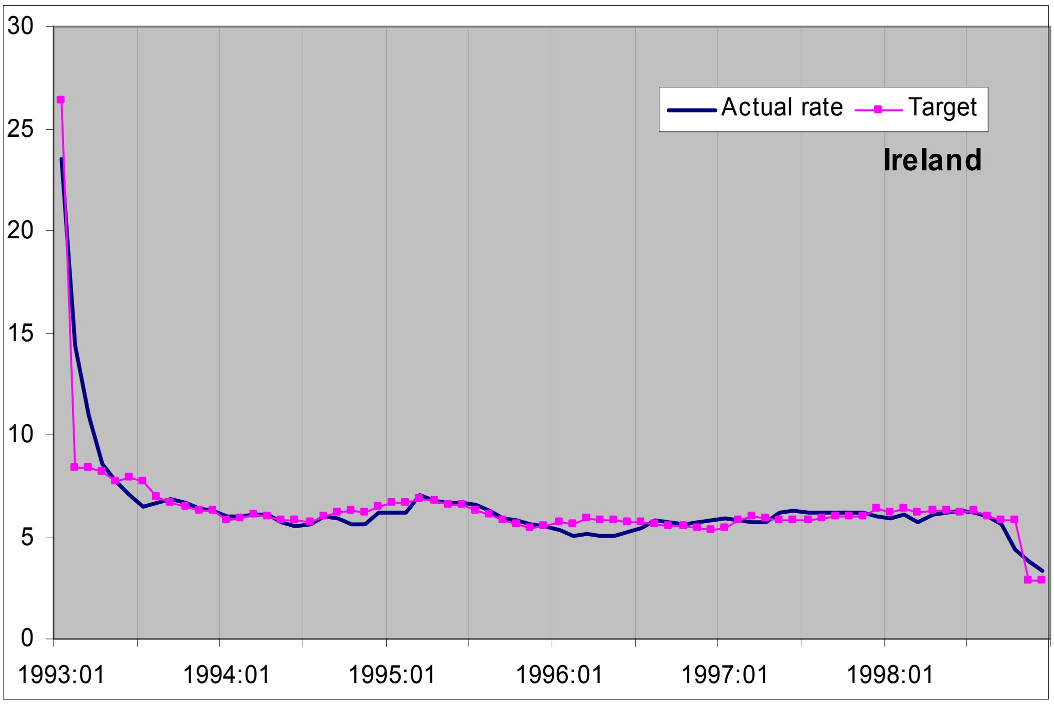


Figure B7

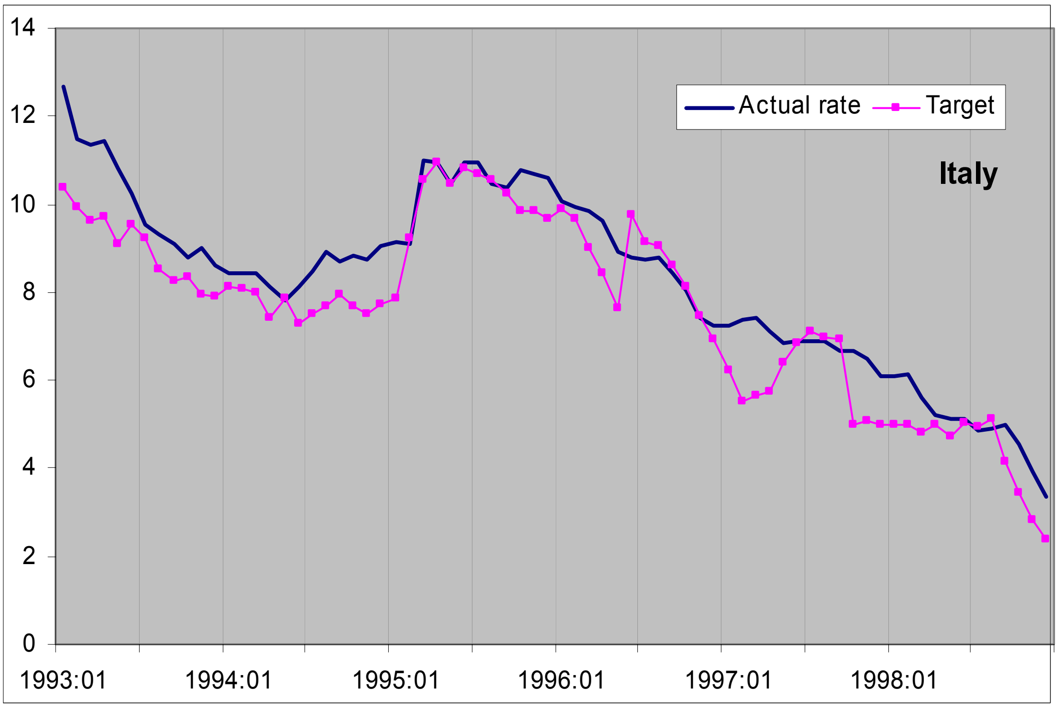


Figure B8

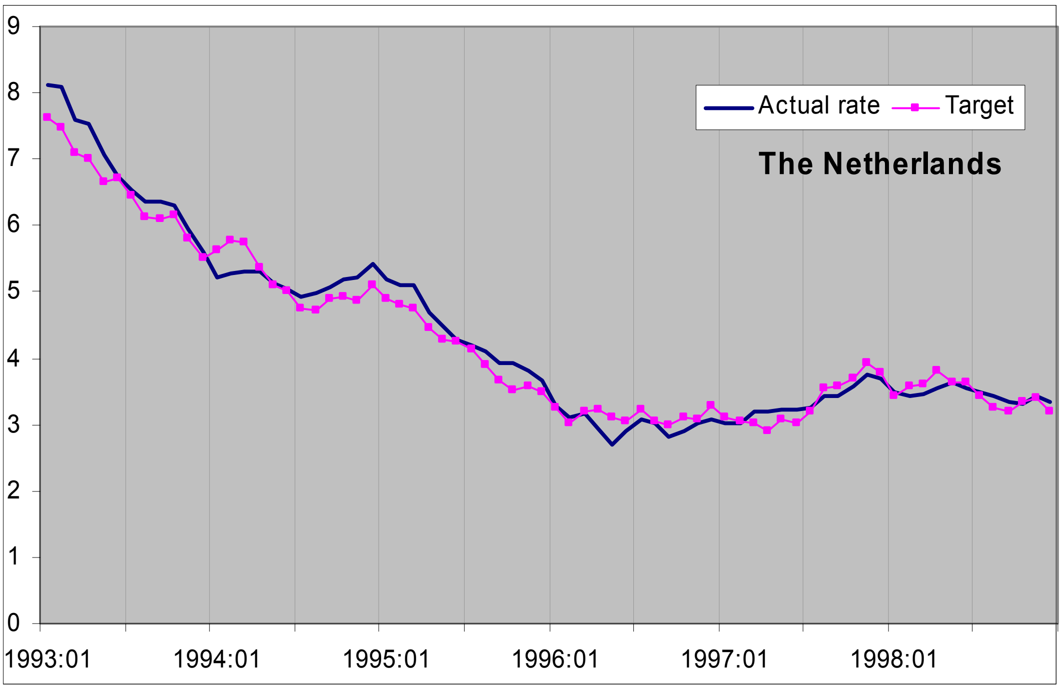


Figure B9

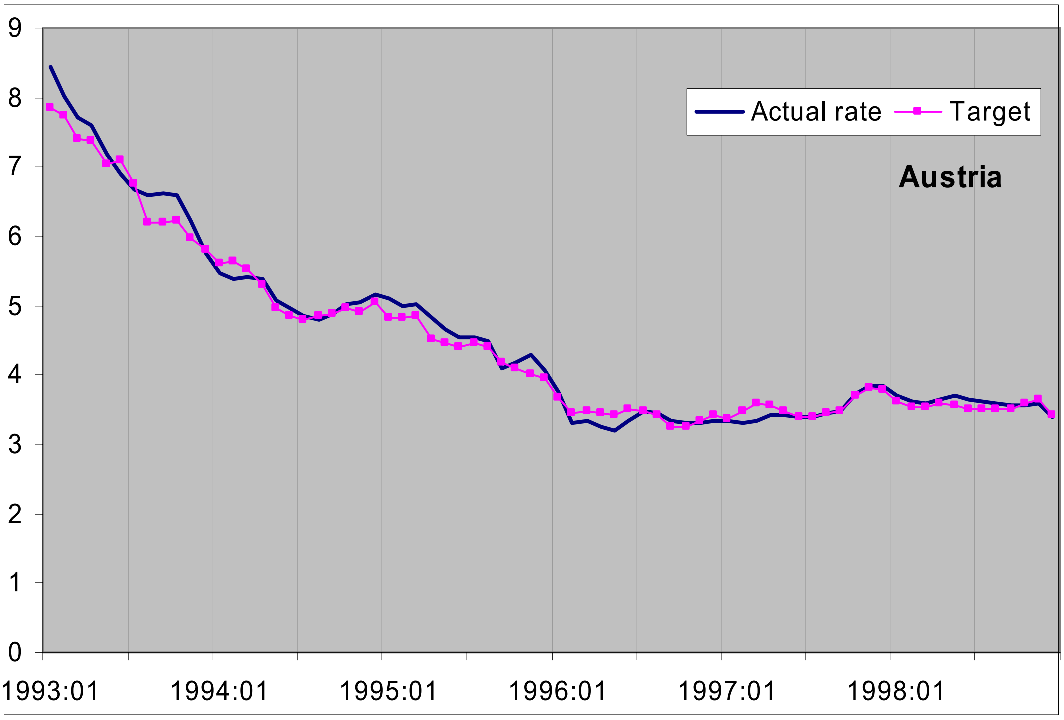


Figure B10

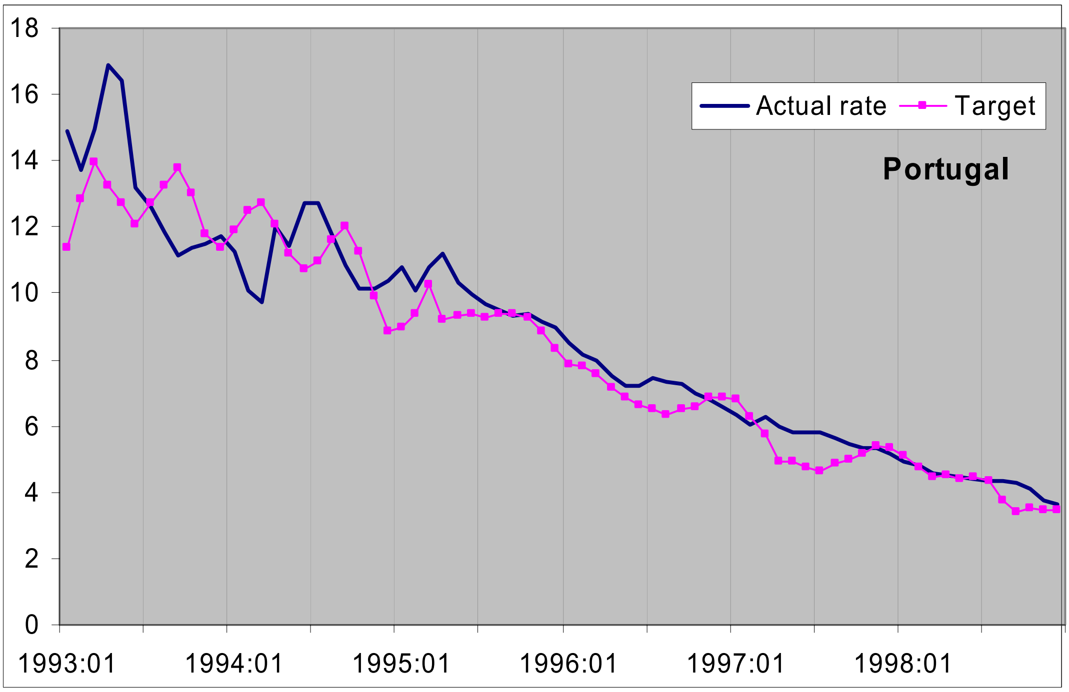
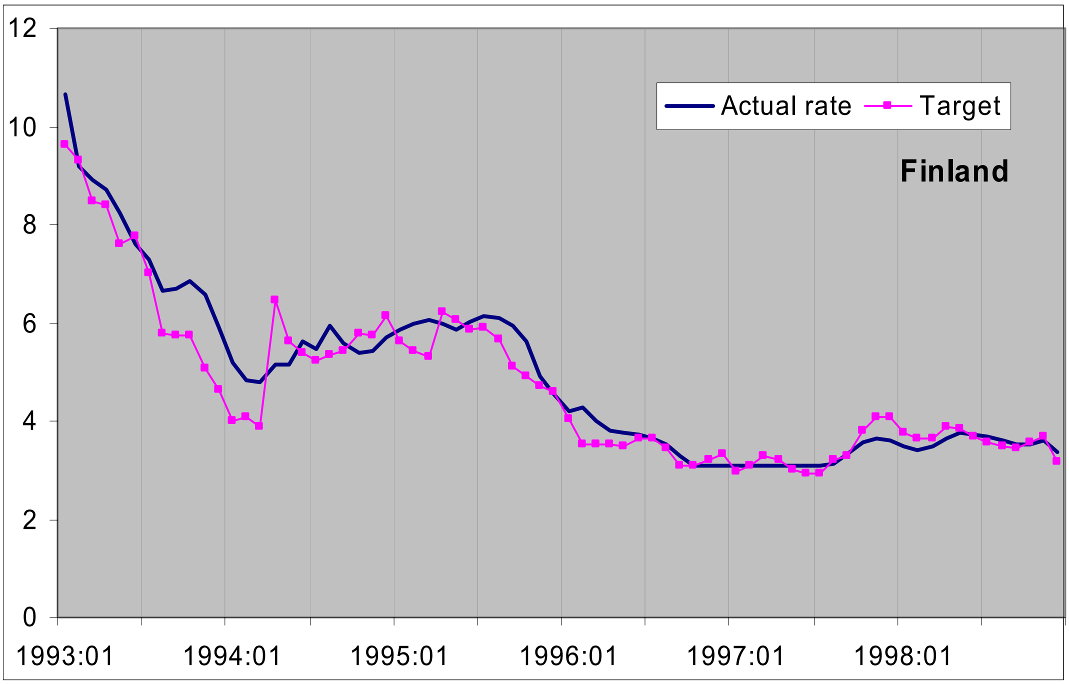


Figure B11



12
10
8
6
4
2
0
Actual rate
Target
Finland
1993:01
1994:01
1995:01
1996:01
1997:01
1998:01

Figure B12

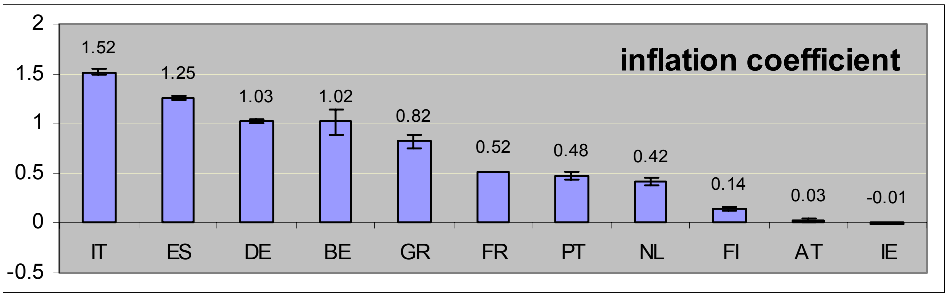


Figure B13

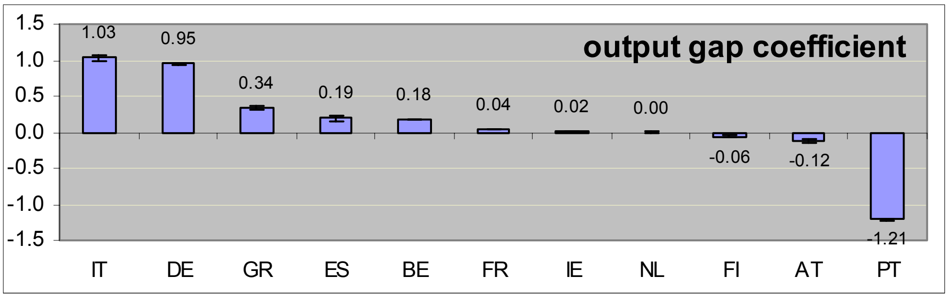


Figure B14

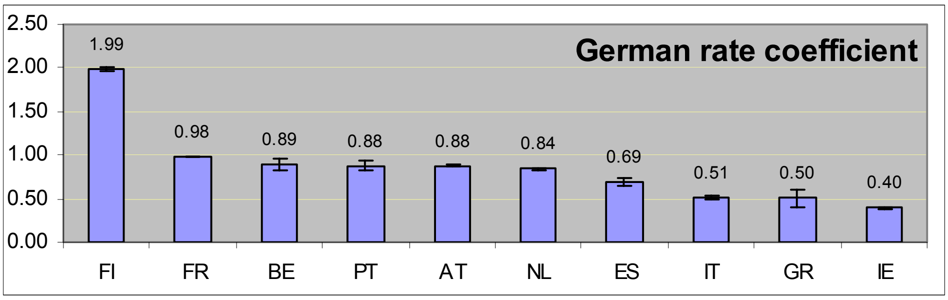


Table B1

	BE: contemporaneous plus German interest rate					DE: contemporaneous plus M3 and exchange rate			
	bpf	hpf	lt	qt		bpf	hpf	lt	qt
Alpha	**0.34**	**-1.05**	**-1.11**	**1.37**	**Alpha**	**1.93**	**2.82**	**2.61**	**2.06**
t-stat	*7.94*	*-7.95*	*-8.63*	*9.19*	*t-stat*	*56.22*	*89.03*	*67.08*	*52.43*
Beta	**0.20**	**1.05**	**1.02**	**0.55**	**Beta**	**1.43**	**1.03**	**0.66**	**1.23**
t-stat	*7.92*	*7.48*	*7.77*	*8.97*	*t-stat*	*71.56*	*58.66*	*21.51*	*28.47*
Gamma	**0.19**	**0.18**	**0.18**	**0.57**	**Gamma**	**0.94**	**0.95**	**0.09**	**-0.17**
t-stat	*11.36*	*4.47*	*4.62*	*9.77*	*t-stat*	*38.19*	*67.16*	*2.98*	*-6.14*
Rho	**0.57**	**0.86**	**0.86**	**0.87**	**Rho**	**0.85**	**0.77**	**0.87**	**0.90**
t-stat	*79.63*	*56.85*	*55.18*	*168.97*	*t-stat*	*421.00*	*145.25*	*194.74*	*316.87*
Delta	**0.83**	**0.86**	**0.89**	**0.20**	**Delta**	**0.03**	**0.02**	**0.15**	**-0.03**
t-stat	*97.26*	*11.32*	*12.44*	*5.18*	*t-stat*	*5.57*	*4.62*	*27.49*	*-2.75*
Theta					**Theta**	**0.11**	**0.06**	**0.24**	**0.22**
t-stat					*t-stat*	*25.78*	*27.52*	*29.49*	*38.56*
adjR2	**0.93**	**0.95**	**0.95**	**0.95**	**adjR2**	**0.99**	**0.99**	**0.99**	**0.99**
J-stat	**1.00**	**1.00**	**1.00**	**1.00**	**J-stat**	**1.00**	**1.00**	**1.00**	**1.00**

	GR: forward-looking plus German interest rate					ES: contemporaneous plus M3			
	bpf	hpf	lt	qt		bpf	hpf	lt	qt
Alpha	**6.65**	**6.94**	**6.71**	**6.93**	**Alpha**	**-0.79**	**17.92**	**0.00**	**-20.90**
t-stat	*28.28*	*30.85*	*30.00*	*30.61*	*t-stat*	*-4.69*	*0.88*	*0.00*	*-0.92*
Beta	**0.71**	**0.82**	**0.93**	**0.89**	**Beta**	**1.49**	**-13.44**	**0.00**	**9.28**
t-stat	*11.14*	*13.24*	*10.35*	*11.32*	*t-stat*	*26.50*	*-0.77*	*0.00*	*1.14*
Gamma	**0.51**	**0.34**	**0.17**	**0.21**	**Gamma**	**2.29**	**-30.16**	**0.00**	**4.02**
t-stat	*9.82*	*7.52*	*4.80*	*5.66*	*t-stat*	*22.58*	*-0.86*	*0.00*	*0.98*
Rho	**0.69**	**0.68**	**0.67**	**0.67**	**Rho**	**0.80**	**0.99**	**0.00**	**0.99**
t-stat	*41.82*	*45.83*	*39.02*	*40.89*	*t-stat*	*150.33*	*138.20*	*0.00*	*95.87*
Delta	**0.71**	**0.50**	**0.45**	**0.45**	**Delta**	**4.22**	**-45.68**	**0.00**	**-53.55**
t-stat	*6.29*	*4.94*	*3.43*	*3.85*	*t-stat*	*19.85*	*-0.87*	*0.00*	*-0.97*
D94.04	**19.11**	**16.78**	**14.92**	**15.21**	**D93.01-8*gap**	**-2.68**	**39.17**	**0.00**	**-23.91**
t-stat	*3.71*	*3.90*	*4.30*	*4.21*	*t-stat*	*-22.77*	*0.89*	*0.00*	*-0.92*
D94.05	**161.76**	**155.63**	**151.74**	**151.75**	**D93.08-94.11**	**0.41**	**-17.32**	**0.00**	**-16.93**
t-stat	*18.56*	*20.28*	*18.28*	*18.97*	*t-stat*	*5.31*	*-0.89*	*0.00*	*-0.92*
D97.11	**26.63**	**22.46**	**21.08**	**21.26**					
t-stat	*5.80*	*3.76*	*3.41*	*3.48*					
adjR2	**0.94**	**0.95**	**0.95**	**0.95**	**adjR2**	**0.98**	**0.98**	**0.00**	**0.98**
J-stat	**1.00**	**1.00**	**1.00**	**1.00**	**J-stat**	**1.00**	**1.00**	**0.00**	**1.00**

Table B1 (continued)

	FR: forward-looking plus German interest rate and M3					IE: contemporaneous plus German and UK interest rates			
	bpf	hpf	lt	qt		bpf	hpf	lt	qt
Alpha	**0.10**	**-0.13**	**-0.08**	**-0.04**	**Alpha**	**3.62**	**3.70**	**3.32**	**3.74**
t-stat	*9.51*	*-10.72*	*-4.42*	*-2.19*	*t-stat*	*77.17*	*78.33*	*48.64*	*66.11*
Beta	**0.77**	**0.53**	**0.52**	**0.50**	**Beta**	**0.26**	**0.26**	**0.33**	**0.23**
t-stat	*114.74*	*108.62*	*101.13*	*111.85*	*t-stat*	*27.06*	*24.73*	*28.83*	*23.91*
Gamma	**0.51**	**0.04**	**0.04**	**0.05**	**Gamma**	**0.13**	**0.10**	**0.10**	**0.09**
t-stat	*57.30*	*8.00*	*7.48*	*9.07*	*t-stat*	*18.85*	*21.71*	*42.04*	*21.85*
Rho	**1.10**	**0.91**	**0.91**	**0.89**	**Rho**	**0.43**	**0.43**	**0.40**	**0.43**
t-stat	*577.42*	*334.09*	*331.00*	*349.20*	*t-stat*	*316.38*	*192.23*	*110.52*	*186.54*
Delta	**0.98**	**0.98**	**0.98**	**0.96**	**Delta**	**0.43**	**0.44**	**0.65**	**0.49**
t-stat	*361.67*	*604.07*	*430.62*	*298.40*	*t-stat*	*40.99*	*39.73*	*43.53*	*34.09*
Theta	**0.04**	**0.23**	**0.23**	**0.22**	**Theta**	**0.02**	**0.03**	**0.02**	**0.03**
t-stat	*4.46*	*41.90*	*38.79*	*38.82*	*t-stat*	*12.34*	*11.94*	*10.74*	*10.06*
Rho (t-2)	**-0.32**	**-0.36**	**-0.36**	**-0.36**	**D93.01**	**18.92**	**18.87**	**17.75**	**18.81**
t-stat	*-130.61*	*-99.44*	*-104.57*	*-113.86*	*t-stat*	*443.06*	*383.28*	*178.82*	*334.98*
					D98.11-12	**-1.99**	**-2.45**	**-3.11**	**-2.81**
					t-stat	*-28.74*	*-33.59*	*-16.51*	*-27.77*
adjR2	**0.96**	**0.95**	**0.95**	**0.95**	**adjR2**	**0.98**	**0.98**	**0.98**	**0.98**
J-stat	**1.00**	**1.00**	**1.00**	**1.00**	**J-stat**	**1.00**	**1.00**	**1.00**	**1.00**

	IT: contemporaneous plus German interest rate					NL: contemporaneous plus German interest rate			
	bpf	hpf	lt	qt		bpf	hpf	lt	qt
Alpha	**-1.77**	**-1.97**	**-0.60**	**-0.13**	**Alpha**	**-0.20**	**-0.22**	**-0.22**	**-0.12**
t-stat	*-9.31*	*-8.75*	*-3.66*	*-0.95*	*t-stat*	*-4.34*	*-4.06*	*-4.91*	*-2.45*
Beta	**1.94**	**2.25**	**1.52**	**1.13**	**Beta**	**0.48**	**0.47**	**0.42**	**0.51**
t-stat	*30.37*	*35.40*	*43.33*	*36.40*	*t-stat*	*9.93*	*9.85*	*11.47*	*9.75*
Gamma	**1.00**	**0.76**	**1.03**	**1.05**	**Gamma**	**-0.15**	**-0.04**	**-0.01**	**-0.08**
t-stat	*18.33*	*17.80*	*34.36*	*29.15*	*t-stat*	*-4.17*	*-3.43*	*-1.47*	*-4.15*
Rho	**0.73**	**0.72**	**0.65**	**0.68**	**Rho**	**0.74**	**0.74**	**0.69**	**0.75**
t-stat	*63.56*	*64.47*	*65.80*	*80.67*	*t-stat*	*40.82*	*37.84*	*34.57*	*38.88*
Delta	**0.45**	**0.32**	**0.51**	**0.37**	**Delta**	**0.80**	**0.82**	**0.84**	**0.81**
t-stat	*9.51*	*8.41*	*29.23*	*21.74*	*t-stat*	*41.01*	*48.44*	*59.30*	*46.52*
D96.06-97.09	**3.57**	**4.00**	**3.19**	**2.64**					
t-stat	*26.95*	*28.83*	*41.59*	*37.07*					
D97.10-98.08	**0.75**	**0.89**	**0.68**	**0.82**					
t-stat	*3.86*	*4.52*	*3.96*	*6.87*					
adjR2	**0.97**	**0.96**	**0.97**	**0.97**	**adjR2**	**0.99**	**0.99**	**0.99**	**0.99**
J-stat	**1.00**	**1.00**	**1.00**	**1.00**	**J-stat**	**1.00**	**1.00**	**1.00**	**1.00**

Table B1 (continued)

	AT: forward-looking plus German interest rate					PT: contemporaneous plus German interest rate (-3)			
	bpf	hpf	lt	qt		bpf	hpf	Lt	qt
Alpha	**0.61**	**0.49**	**0.48**	**0.65**	**Alpha**	**1.66**	**0.91**	**1.41**	**1.86**
t-stat	*29.59*	*18.48*	*16.26*	*19.49*	*t-stat*	*6.34*	*7.26*	*10.81*	*5.36*
Beta	**0.03**	**0.02**	**0.03**	**-0.04**	**Beta**	**1.48**	**0.51**	**0.48**	**0.67**
t-stat	*2.53*	*1.45*	*2.17*	*-2.82*	*t-stat*	*21.20*	*14.59*	*11.56*	*6.12*
Gamma	**-0.14**	**-0.09**	**-0.12**	**0.00**	**Gamma**	**-1.65**	**-1.06**	**-1.21**	**-0.42**
t-stat	*-13.47*	*-13.94*	*-15.87*	*-0.07*	*t-stat*	*-16.22*	*-95.42*	*-90.91*	*-2.95*
Rho	**0.66**	**0.65**	**0.65**	**0.73**	**Rho**	**0.97**	**1.17**	**1.14**	**0.87**
t-stat	*55.04*	*41.71*	*45.55*	*51.87*	*t-stat*	*79.59*	*77.61*	*84.46*	*87.38*
Delta	**0.84**	**0.86**	**0.88**	**0.83**	**Delta**	**-0.13**	**0.78**	**0.88**	**0.39**
t-stat	*104.65*	*82.06*	*84.85*	*61.06*	*t-stat*	*-1.57*	*16.02*	*17.48*	*3.53*
					D93.01-95.03	**1.49**	**0.77**	**1.16**	**6.46**
					t-stat	*5.15*	*6.50*	*9.34*	*19.54*
					Rho (t-2)	**-0.10**	**-0.42**	**-0.39**	**0.03**
					t-stat	*-5.78*	*-35.23*	*-32.36*	*2.91*
adjR2	**0.99**	**0.99**	**0.99**	**0.99**	**adjR2**	**0.96**	**0.96**	**0.96**	**0.95**
J-stat	**1.00**	**1.00**	**1.00**	**1.00**	**J-stat**	**1.00**	**1.00**	**1.00**	**1.00**

	FI: contemporaneous plus German interest rate			
	bpf	hpf	lt	qt
Alpha	**-2.62**	***-3.26***	**-3.59**	**-3.54**
t-stat	*-25.09*	*-34.34*	*-40.62*	*-38.19*
Beta	**-0.01**	***0.18***	**0.14**	**0.14**
t-stat	*-0.43*	*4.71*	*6.35*	*3.69*
Gamma	**-0.14**	***-0.06***	**-0.06**	**-0.05**
t-stat	*-13.39*	*-8.76*	*-21.19*	*-9.05*
Rho	**0.71**	***0.71***	**0.63**	**0.71**
t-stat	*76.23*	*64.59*	*63.51*	*65.74*
Delta	**1.79**	***1.92***	**1.99**	**1.99**
t-stat	*48.28*	*50.01*	*68.89*	*53.98*
D93.01-94.03	**-4.34**	***-4.74***	**-4.85**	**-4.84**
t-stat	*-52.89*	*-43.28*	*-46.30*	*-46.03*
D94.04-95.03	**-1.29**	***-1.75***	**-1.74**	**-1.84**
t-stat	*-16.73*	*-25.92*	*-29.35*	*-27.61*
adjR2	**0.97**	***0.98***	**0.98**	**0.98**
J-stat	**1.00**	***1.00***	**1.00**	**1.00**

Note: "BPF", "HPF", "LT" and "QT" stand for the Band-Pass, the Hodrick-Prescott, the linear trend and the quadratic trend methods, respectively. Shadowed columns indicate specifications presented in Section 3. Columns in italics indicate non-convergent specifications and columns filled with zeros correspond to cases for which estimation has not been possible due to singularity.

Appendix C: Description of the data

Country denomination: BE=Belgium, DE=Germany, GR=Greece, ES=Spain, FR=France, IE=Ireland, IT=Italy, LU=Luxembourg, NL=Netherlands, AT=Austria, PT=Portugal, FI=Finland.

Exchange rates:
All countries (except DE, LU): nominal exchange rate of the respective national currency against the Deutsch Mark. The series is derived as the cross rate of the respective national currency and the Deutsch Mark against the US dollar, spot at 2.15 PM (CET)- monthly average (Source: BIS).
DE: nominal exchange rate of the Deutsch Mark against the US dollar or against the ECU, spot at 2.15 PM (CET)- monthly average (Source: BIS).

Output:
All countries: seasonally adjusted real GDP series (at constant 1995 market prices), on a quarterly frequency (Source: Eurostat, National sources). The series have been interpolated on a monthly frequency using the cubic spline method.

Three-month money market interest rate
BE: three-month Treasury certificates rate (Source: BIS).
DE: three-month money market rate on loans (Source: BIS).
ES: three-month interbank deposit rate (Source: BIS).
FR: three-month Paris interbank offered rate (Source: BIS).
NL: three-month AIBOR rate (Source: BIS).
GR: three-month ATHIBOR rate (Source: BIS).
IT: three-month interbank loans rate (Source: BIS).
IE: from February 1979 onwards, three-month fixed interbank deposits rates (Source: BIS).
AT: three-month interbank VIBOR rate (Source: BIS).
PT: from February 1989 onwards, three-month interbank deposits rate (Source: BIS).
FI: three-month HELIBOR rate (Source: BIS).
Euro-Area: three- month money market rate (Source: BIS).

Monetary aggregate
All countries: M3 is constructed using data on non-seasonally adjusted month-end stocks and flows as follows: the index of adjusted stocks is re-based to be equal to 100 in January 2001 and then multiplied by the stock in January 2001. The percentage change between any two dates (after October 1997) corresponds to the change in the stock excluding the effect of reclassifications, other revaluations and exchange rate variations. The series is then seasonally adjusted using the X-ARIMA 12 available in E-views.

Prices
All countries: from January 1992 onwards, the seasonally adjusted Harmonized Index of Consumer Prices (HICP) is used. Before are used the monthly rates of change of national Consumer Price Index (CPI)- excluding owner occupied housing (except for Spain). Calculations are carried out by the ECB on the basis of national and Eurostat data.

Unemployment
BE, FR, IT, IE, LU, PT: seasonally adjusted standardized unemployment rate (Source: Eurostat).
DE, ES, NL, FI: seasonally adjusted standardized unemployment series (Source: OECD).
GR: national definition of the unemployment rate (seasonally adjusted, Source: BIS)- a standardized series do not exist.

AT: from January 1993 onwards, seasonally adjusted standardized unemployment series (Source: Eurostat). Before this date, seasonally adjusted series built on the national definition series (Source: OECD). The former series is backdated with ECB calculations: the ratio of the two last OECD observations is multiplied with the first Eurostat observation.

Commodity prices

World market prices of raw materials (total index) converted into euro. The weighting scheme is based on commodity imports of OECD countries, 1989-1991, excluding EU-internal trade.

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