Do All Fit One Size?
An Evaluation of the ECB Policy Response to the Changing Economic Conditions in Euro Area Member States

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Abstract

This paper empirically investigates the extent to which the European Central Bank has responded to evolving economic conditions in its member states as opposed to the euro area as a whole. Based on a Taylor rule-type policy reaction function, we conduct counterfactual exercises that compare the monetary policy behavior of the ECB with the alternative hypothetical scenarios (1) were the euro member states to make individual policy decisions, and (2) were the ECB to respond to the economic conditions of individual members. Reflecting the extent of heterogeneity among the national economies in the monetary union, empirical results indicate that the ECB's monetary policy rates have been particularly close to the "counterfactual" interest rates of its largest euro member, namely Germany, as well as countries with similar economic conditions, including Austria, Belgium and France .

JEL Classifications: E5, C5

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1. Introduction

In 1999, all but four members of the European Union participated in the third stage of the Economic and Monetary Union by adopting the euro as their national currency and transferring responsibility for monetary policy to the European Central Bank (ECB)—the hub institution of the Eurosystem. The official policy stance of the ECB is that monetary policy decisions are reflective of changing economic conditions of the euro area as a whole, and do not reflect any diversity among the national economies within the region (Duisenberg, 2002). While formation of the ECB is necessary for a complete monetary union between EU member states, its "one size fits all" monetary policy has faced criticisms on many fronts.

The efficacy of a single monetary policy for all EMU members is akin to the issue whether the members constitute an optimum currency area. Above all, the significant amount of diversity that remains among EMU members today constitutes a challenge to the implementation of a single currency or monetary policy. A growing volume of literature (e.g., Faust *et al*., 2001; Carstensen, 2006; Arestis and Chortareas, 2006; Fendel and Frenkel, 2006) has attempted to evaluate the performance of the ECB in managing the aggregate economy of the euro area. For instance, Faust *et al.* (2001) rely on the behavior of Germany's Bundesbank in the pre-euro period as a benchmark to evaluate the ECB policy. Many of these studies are, however, hampered by the short history of the ECB, so the results of these earlier studies appear to be rather fragile and/or anecdotal.

The objective of the present paper is to evaluate the performance of the ECB by comparing its historical policy behavior against the hypothetical monetary policies of its members. More specifically, we ask two related questions: (1) What would the policy interest rates have been if the ECB were to make policy decisions based on the economic conditions of individual euro area member states instead of the euro area as a whole?; and (2) What would the interest rates of euro area member states have been if their central banks were given the power to make individual policy decisions? The two questions are addressed using counterfactual exercises with a popular Taylor rule-type policy reaction function.

In addition to the counterfactual analysis—an approach different from the traditional regression-based methods in earlier studies—our work contributes to the existing monetary policy literature in two directions. First, our results benefit from nearly a decade of ECB history as opposed to earlier studies with limited data observations. Second, we implement recursive estimation to accommodate observed instability in feedback coefficients of the reaction functions. This method allows us to model evolving monetary policy conduct, particularly in terms of central banks' changing weights on individual economic variables.

The rest of this paper is organized as follows. The second section discusses the methodology and data. The third section presents the estimation results based on a Taylor rule-type reaction function. The fourth section discusses the results of some counterfactual exercises in order to evaluate the monetary policy implications of disparate economic experiences among euro area member states. The fifth section concludes the paper.

2. Empirical Methodology

2.1. The Taylor Rule

We explore central bank behavior using the Taylor rule, which has become the most popular formulation of a monetary policy reaction function.[1] Following Clarida *et al.* (1998) and Faust *et al.* (2001), among others, the baseline specification of a dynamic version of the Taylor rule for a central bank's policy instrument i_t is expressed as:

$$i_t = \rho i_{t-1} + (1-\rho) i_t^* + \varepsilon_t \qquad (1)$$

where ε_t is an i.i.d. error term with a zero mean. The term i_t^* denotes the central bank's "target" interest rate, and the parameter ρ captures the interest-rate smoothing behavior in monetary policy conduct, or policy inertia.

According to this forward-looking version of the policy reaction function, the central bank responds to (i) the expected rate of inflation (π_t) between periods t and $t+n$ that is above its targeted rate π_t^*, and (ii) the current expected value of the output gap, which is the difference between expected output level (y_t) and the potential output level y_t^*. Price stability and output stabilization are widely considered as the dual objectives of many central banks. For the ECB, however, we augment the conventional Taylor rule with an additional variable, namely the growth rate of a monetary aggregate. Especially before 2003, the ECB has officially followed a two-pillar strategy (ECB, 2003).[2] The first pillar reflects developments in monetary growth, particularly in the broad M3 monetary aggregate, and the second pillar represents overall economic conditions that are captured by the typical Taylor rule. From this perspective, the ECB's "target" rate can be written as:

$$i_t^* = \beta_0 + \beta_1(E[\pi_{t+n} \mid \Omega_t] - \pi_t^*) + \beta_2(E[y_t \mid \Omega_t] - y_t^*) + \beta_3(E[m_t \mid \Omega_t] - m_t^*) \qquad (2)$$

where m_t denotes money growth, m_t^* its targeted rate, and E is an expectation operator given the information available to the central bank at time t, Ω_t.

To facilitate cross-country comparisons, we follow recent studies (e.g., Clarida *et al.*, 1998) and first estimate the "target" rate model with a zero targeted inflation rate, i.e., $\pi_t^* = 0$.

ECB officials (ECB, 1998, 2003) have explicitly defined price stability as an inflation rate below 2% over the medium term, but price stability is generally considered as a zero inflation rate. Similarly, we consider the expected growth rate of M3 in specifying the reaction function. Although the ECB has announced a reference value of 4.5% for annual M3 growth (ECB, 1998), Huchet (2003) asserts that it has never attempted to keep monetary growth at that reference value by changing interest rates. Moreover, various studies (e.g., Favero *et al*., 2000; Svensson, 2000) have shown that monetary growth has never played a meaningful role in the monetary policy practice of the ECB.

Against this background, we consider the following dynamic version of the Taylor rule:

$$i_t = \rho i_{t-1} + (1-\rho)\{\beta_0 + \beta_1 E[\pi_{t+n} \mid \Omega_t] + \beta_2 (E[y_t \mid \Omega_t] - y_t^*) + \beta_3 E[m_t \mid \Omega_t]\} + \varepsilon_t . \qquad (3)$$

The policy feedback coefficients β_1, β_2 and β_3 reflect the central bank's respective attention to price stability, economic activity and monetary growth in making monetary policy decisions. Various studies (e.g., Arestis and Chortareas, 2006; Cartensen, 2006; Fendel and Frenkel, 2006; Hayo and Hofmann, 2006; Huchet, 2003) have used the above Taylor-type reaction function with or without the monetary variable to examine monetary policy for the euro area. Clarida *et al.* (1998) also find that this reaction function specification provides a good representation of monetary policy for major central banks in periods particularly after the early 1980s.

An earlier version of the Taylor (1993) rule employs only lagged values of the independent variables, implying a backward-looking monetary policy behavior. However, Clarida *et al*. (1998), Faust *et al*. (2001), and Fernandex and Nikolsko-Rzhevskyy (2007) find that the forward-looking model specification, as captured by equation (2), better reflects monetary policy conduct of major central banks than do its backward-looking counterparts.

2.2. Estimation Issues

There are two issues in estimating the policy reaction function captured by equation (3). Both issues arise from the fact that data for the independent variables are not directly observable at the time that monetary policy decisions are made. First, the forward-looking specification of the Taylor rule assumes that policymakers react to their expectations about future inflation and the output gap, not their past realized values. Second, data for the output gap require information about the potential output level, which is also not directly observable.

For inflation expectations, we consider central banks' policy responses to one-period ahead expectations of inflation (n=1). Central banks' own published forecasts serve as reasonable measures for the expected inflation and output gap data. Such forecasts, however, are largely unavailable for countries other than the U.S. and the U.K. Following most studies in the recent literature, including Clarida *et al.* (1998) and Muscatelli *et al.* (2002), we instead adopt the errors-in-variables approach that involves the generalized method of moments (GMM) to estimate *ex post* realized data along with a set of instrumental variables. To reflect policymakers' information set at the time of an interest rate decision, the instruments include four lagged values of the policy interest rate, inflation and output gap series. GMM estimations are carried out using an optimal weighting matrix that accounts for potential heteroskasticity and serial correlation in the error term.

Another estimation issue concerns the data for potential output. A popular method to obtain estimates for potential output is to extract a nonlinear trend from GDP data using the Hodrick-Prescott (HP) filter or a band pass filter. However, Laubach and Williams (2003) argue that these univariate filters ignore information from movements in inflation and thus provide a misleading picture of the recent trends in such variables as interest rates and output. These filters are also inappropriate from the conceptual perspective. As Muscatelli *et al.* (2002) point out, they are commonly executed using the full sample of estimation data, meaning that policymakers are assumed to possess information about future GDP data that they in fact do not know in real time.

To better model policymakers' decision making process, we obtain a measure of the output gap using a structural approach. Following King *et al.* (1995) and Lee (2000), among others, we extract the unobservable trend component of the output series in line of an expectations-augmented Phillips curve model:

$$\pi_t = \sum_{i=1}^{4} \phi_i \pi_{t-i} + \theta(y_t - y_t^*) + \sum_{i=1}^{4} \varphi_i oil_{t-i} + \eta_t \tag{4}$$

where the variable *oil* controls for the influence of supply shocks and is measured by the first-difference of the log world crude oil price level. In equation (4), potential output y_t^* captures the level of output consistent with stable inflation, ignoring the transitory shocks to aggregate supply. The term y_t^* is an unobservable component that is estimated by a recursive Kalman filter in a state-space form along with the assumption that y_t^* follows a random walk (plus drift):[3]

$$y_t^* = \delta + y_{t-1}^* + \upsilon_t. \tag{5}$$

2.3. Data

We examine quarterly data beginning in 1994, when the forerunner of the ECB—European Monetary Institute—was created. Except for M3, the data are available at OECD's *Main Economic Indicators*.[4] Today, the euro area consists of 13 countries, including the 11 original stage three members of the EMU, Greece (joining in 2001) and Slovenia (joining in 2007). Because our dataset ends in 2005, the euro area consists of the first 12 countries, excluding Slovenia.

Inflation is measured by the fourth-quarter (annual) percentage change in the Consumer Price Index. To gain some perspective on the extent of heterogeneity across national economies in the euro area, we plot the inflation data for individual countries in Figure 1 along with the area-wide data. Prior to joining the monetary union, inflation declined noticeably in most countries, especially Greece, Italy and Portugal. In the post-euro period, however, the patterns of inflation remained quite different among euro area member states.

The output gap is measured by 100 times the log level of real GDP less the log level of potential GDP. Following Clarida *et al.* (1998), among others, the measure of monetary policy instrument is the equivalent of the overnight interbank lending rate. For example, such a rate for Germany before 1999 is its call rate. Interest rate data for the ECB between 1994 and 1998 are taken for all banks included in the calculation of the Euribor. Beginning in 1999, the interest rates for euro area member states are identical to the policy rate of the ECB, as measured by the European Overnight Index Average (EONIA).

The money growth variable is measured by the fourth-quarter (annual) percentage change in M3. Even though the ECB publishes M3 data for the euro area as a whole, corresponding data for individual member states are not publicly available. To deal with this problem, we use

Mehrotra's (2007) estimates for the national contributions to euro area M3. The data are available only for 9 member states (excluding Greece, Ireland and Luxembourg).

3. Estimation Results

3.1. Full Sample Period Results

Table 1 reports GMM estimation results for the euro area as well as its member states over the period 1994:1-2005:4. Judging by the standard errors of estimates (SEE) in the sixth column of Table 1, the Taylor rule fits the data of Austria and Germany better than other EMU countries as well as the euro area as a whole. It is also noteworthy that all of the reported *J*-statistics (seventh column) for testing overidentifying restrictions indicate that the selected set of instruments in model estimations is relevant. In other words, the statistics support the exogeneity property of the instrumental variables with respect to monetary policy decisions.

For most countries except Greece, the estimated coefficient for the lagged policy rate (ρ) is fairly close to one, implying a great deal of "inertia" in monetary policy.[5] The intercept term (β_0) in the "target" rate equation represents the equilibrium or long-run "target" rate. The respective estimates vary remarkably across countries and some are even negative (Greece, Ireland, Italy, Portugal and Spain).

Similarly, the coefficient estimates for the future inflation variable vary widely across countries. The estimate for the euro area as a whole is about 1.4, which differs remarkably from those of individual countries. The estimates for Finland, Greece, Ireland, Italy and Spain are relatively higher, suggesting aggressive responses to expected inflation from these countries. On the other hand, the estimates for other countries are statistically insignificant. Unlike the estimates for inflation, the output gap coefficient estimates are mostly positive, except for the case of Portugal.

For the 9 countries that we have M3 data, the reaction function includes M3 growth in addition to inflation and the output gap. For the euro area, the coefficient estimate for the money growth variable enters with a negative sign, reflecting the expected relationship between money growth and interest rates. The evidence of such a relationship is, however, much weaker among member states. In the cases of Finland and Portugal, the estimate even enters with a positive sign.

3.2. Structural Change

Before proceeding further with the estimation results, it makes sense to first test for structural stability in the estimated model parameters. Particularly for euro area member states, handing over monetary policy to the ECB could lead to a change in policy feedback coefficients and thus parameter instability in the estimated policy reaction functions.

To explore possible parameter instability, we consider Chow-type tests with *a priori* unknown break points. Specifically, we compute Andrews and Ploberger's (1994) *MeanF* and *SupF*, and Hansen's (1992) L_c statistics for estimating equation (3) as described in the preceding section. The Andrews-Ploberger tests are primarily for detecting a sudden break, while the Hansen test is for a smooth change.

Test results for the estimated Taylor rule are reported in the last three columns of Table 1. The null hypothesis for all tests is constancy in all estimated parameters. Parameter instability is evident for most countries the sample and the euro area, even though not all alternative statistics are significant. The L_c statistics overall provide stronger evidence of structural change than the

MeanF or *SupF* statistics do. In other words, the bulk of euro area member states witnessed a gradual rather than abrupt change in monetary policy reaction over the estimation period.

3.3. Recursive Estimation Results

In light of the evidence of structural instability in the estimated policy reaction function, we follow a procedure similar to Boivin (2006) and allow for evolution in parameters by applying recursive estimations with a fixed window. For each country, we first run GMM estimation of equation (3) using data over the period 1994:1-1999:1. Sequentially, we re-estimate the model by adding data one period at a time until the estimation reaches the end of our observation period in 2005:4. Because Greece did not become part of the Eurosystem until 2001, its Taylor rule estimation ends at 2000:4 and the first period for recursive coefficient updating is 2001:1.

Figure 2 illustrates over time recursive estimates of the coefficients on the lagged interest rate (ρ), intercept (β_0), inflation (β_1), the output gap (β_2), and money growth (β_3). The time periods shown in the plots refer to the final period of recursive estimation. The solid lines are coefficient estimates, encapsulated by the plus and minus two standard error intervals (shaded bands). To facilitate comparisons, we also superimpose the respective coefficient estimates for the euro area (dotted lines).

The plots for the estimated coefficients on the lagged interest rate reflect very little adjustment in monetary policy behavior in the face of changing economic conditions. For the euro area as a whole, the estimate is around 0.6 in the first two years of ECB operation before reaching 0.9 in 2004. The overall high degree of interest rate smoothing across countries, particularly Germany, is widely observed in the literature of policy reaction functions, e.g., Clarida *et al.* (1998), and Faust *et al.* (2001).

The intercept term represents the long-run "target" interest rate. The estimate for the euro area hovers around two percent, while the corresponding estimates for some countries (Ireland, Italy, Portugal and Spain) are negative during much of the observation period. The declining trends in the long-run "target" rate measures across countries are associated with their declining inflation trends over the observation period.

For the inflation coefficients, the recursive estimate in the case of the euro area is rather stable at about 1.5 over much of the observation period. There is evidence of convergence over time between the euro area coefficient estimates and the corresponding estimates for some member states (Germany, Ireland and Luxembourg), but divergence for some others (Greece, Netherlands and Spain). At the end of the observation period, however, a statistically significant discrepancy between the two coefficient estimates for most euro area members, except Portugal.

The fourth column of plots shows the output gap coefficient estimates. The estimate for the euro area is qualitatively indifferent from zero before rising to 1.5 beginning in 2004. The ECB's output coefficient estimates are lower than the corresponding estimates for most countries, except Portugal. The comparative results also highlight the extent of heterogeneity among individual economies within the euro area. As emphasized by ECB officials (Duisenberg, 2002), the ECB responds only to the euro area-wide economic conditions. The estimation results imply that policy might appear to be too tight for some euro area member states while too loose for others. More specifically, the ECB's weights on inflation and the output gap are higher than the corresponding weights for some member states while lower than some others.

A few studies of European monetary policy have focused on comparing the behavior of the ECB with the Bundesbank. For example, Faust *et al*. (2001), and Hayo and Hofmann (2006) assert that the ECB in its early years put a higher weight on the output gap relative to the weight on inflation than the Bundesbank would have. However, our estimations that allow model coefficients to drift over time suggest the opposite for much longer observation period.

The last column of plots in Figure 2 shows the coefficient estimates for money growth. For the euro area, the recursive estimates remain negative over the entire observation period, even though they vary noticeably over time. For individual member states, however, the coefficients are positive in the cases of Finland and Portugal. In addition, the estimates are largely indifferent from zero in the cases of Belgium, Germany and Italy. These findings support that the ECB policy rate reflects the monetary conditions of the entire euro area, but not necessarily all its member states.

The disparities between the coefficient estimates for the euro area and individual member states highlight the difficulty of managing different economies with a single monetary policy. However, it remains difficult from the individual plots in Figure 2 to judge whether the monetary policy might be too tight or too loose at a given period of time. For instance, as argued by Judd and Rudebusch (1998), an increase in the coefficient on the output gap may reflect central bank officials' increased emphasis on using developments in the output gap to forecast future inflation. Similarly, monetary growth is widely conceived (e.g., Gerlach and Svensson, 2000) as an indicator of inflationary pressures.

4. Counterfactual Analysis

4.1. Counterfactual Analysis for Policy Rates

Given the estimation results for the Taylor-type reaction function, we ask the following questions: (1) What would the policy rates have been if the ECB made decisions based on the economic data of individual member states instead of the euro area as a whole?; and (2) What would interest rates for a euro area member state have been if its central bank were to make its own policy decisions instead of adopting the ECB policy? To address the first question, we perform a set of counterfactual exercises as follows. For each country, we calculate the path of its interest rate using the estimated coefficients for the ECB but using its own historical values for the explanatory variables. More specifically, we generate "counterfactual" interest rates $(\tilde{i}_t)$ for each member state as:

$$\tilde{i}_t = \hat{\rho}^a \tilde{i}_{t-1} + (1-\hat{\rho}^a)[\hat{\beta}_0^a + \hat{\beta}_1^a \pi_t + \hat{\beta}_2^a (y_t - y_t^*) + \hat{\beta}_3^a m_t] \tag{6}$$

where an "*a*" superscript denotes the corresponding estimate for the euro area and a coefficient with a hat "^" represents a (time-varying) recursive coefficient estimate obtained from the preceding section. Only coefficient estimates that are statistically significant at the 10% level or higher in full-sample estimation (Table 1) are included in generating the "counterfactual" interest rate paths. In addition, the last term is ignored for countries (Greece, Ireland and Luxembourg) without M3 data. Equation (6) essentially generates the hypothetical interest rate series for the ECB by assuming that it made monetary policy decisions for each member state individually based on its national data.

Alternatively, the second question deals with a hypothetical situation in which central banks in the euro area were to set interest rates individually. We assume that the central banks followed a policy rule established prior to 1999:1, as captured by the same Taylor rule in equation 3 estimated over the period 1994:1-1998:4. In other words, we generate another set of "counterfactual" policy interest rates $(\tilde{i}_t)$ by replacing the coefficients in equation (6) with the estimates for the pre-1999 subperiod. Because Greece did not become part of the Eurosystem until 2001, the Taylor rule estimation ends at 2000:4 and the first period of simulation is 2001:1.

Figure 3 shows the results of the counterfactual exercises. The solid lines are in-sample forecasts of the policy rate using the inflation targeters' own recursive coefficient estimates.[6] The shaded bands are the 95% confidence intervals around the in-sample fitted values. For each country, a dotted line is a "counterfactual" series obtained from fitting equation (6) with the recursive coefficient estimates for the ECB reaction function but the values of the explanatory variables for that member state. A dashed line is a "counterfactual" series obtained from fitting equation (6) with the fixed coefficient estimates for individual member states over the pre-1999 subperiod instead of using the ECB coefficients.

The majority of "counterfactual" series implied by the estimated ECB reaction function (dotted lines) mirror the general trends of the fitted interest rates (in-sample fitted values) but they are more volatile. This implies that the ECB monetary policy has been more rigid over time than the hypothetical interest rates that responded to the economic conditions of individual euro area member states. In the cases of Belgium, Germany, Greece, Luxembourg, the Netherlands and Spain, the two series are overall not qualitatively different from each other over the simulation period, as judged by the 95% confidence bands. The two series are the closest for Germany.

In comparison with the first set of "counterfactual" series, there appears more disparity among the second set of "counterfactual" series (dashed lines) that are constructed using the estimated Taylor rules of individual countries over the pre-euro subperiod. Except for Ireland, Portugal and Spain, the "counterfactual" series tend to follow the same trends as the fitted series. There is no meaningful discrepancy between the "counterfactual" interest rate and the fitted rate over time in the cases of Belgium, Luxembourg and the Netherlands. Similar to the first set of counterfactual exercises, these counterfactual exercises suggest that if the majority of national central banks in the euro area were to follow their own policy rules established prior to joining the monetary union, then the their interest rates would have been meaningfully different from those set by the ECB. In particular, the results show that the economic conditions in Greece, Ireland, Portugal and Spain would have dictated higher interest rates than those set by the ECB.

4.2. Counterfactual Analysis for "Target" Rates

The results in the above counterfactual analyses are largely affected by the substantial amounts of interest rate smoothing in monetary policy conduct. As with Faust *et al.* (2001), we alternatively perform counterfactual exercises on the "target" interest rates instead of the *actual* policy rates. To gain some perspective on the importance of focusing on the "target" interest rates, Figure 4 plots the actual interest rates (solid lines) and the fitted "target" values (dotted lines). For each country, the fitted "target" rates are the fitted values using the recursive coefficient estimates in equation (1). These values are essentially predictions of the ECB monetary policy rate as a function of the inflation and the output gap variables. In most cases, the fitted "target" series is less smooth than the actual interest series and any deviation between the two appears temporary over time.

In light of the observed differences between the actual interest rates and the fitted "target" values, we replicate the counterfactual exercises in the previous subsection for the "target" rate instead of the actual policy rate. To do so, we generate a counterfactual “target” rate ($\tilde{i}_t^*$) path for each country using a procedure analogous to that captured by equation (6):

$$\tilde{i}_t^* = \hat{\beta}_0^e + \hat{\beta}_1^e \pi_t + \hat{\beta}_2^e (y_t - y_t^*) + \hat{\beta}_3^e (m_t) \,. \qquad (7)$$

Analogous to the results for *actual* policy rates in Figure 4, Figure 5 shows the counterfactual results for the “target” rates. Again, the solid lines are in-sample forecasts using the countries’ own estimated coefficients, the dotted lines are “counterfactual” series using the ECB’s reaction function, and the dashed lines are “counterfactual” series using the individual countries’ pre-euro reaction function.

The overall findings stand in contrast to those observed in Figure 4. For the counterfactual exercises under the hypothetical scenario that the ECB responded to the economic data of individual countries, there is some discrepancy between the fitted interest rates and the “counterfactual” path (dotted line) for every country. The “counterfactual” path follows most closely the fitted “target” rates in the cases of Greece and Spain. Overall, the two interest rate paths tend to be much closer in the second half of the observation period than the earlier years of ECB history. This reflects convergence of the euro member states.

Under the alternative hypothetical scenario that central banks were able to pursue individual monetary policy, the counterfactual “target” rate path (dashed line) follows the fitted “target” rates most closely in the case of Germany. In that case, the discrepancy between the two series is virtually nonexistent, implying that the ECB policy conduct is a natural extension of the policy of the Bundesbank. Other than Germany, the counterfactual series and fitted “target” rate series are quite close in the cases of Austria, Belgium, Finland and France, which share similar economic conditions with Germany. On the contrary, the counterfactual “target” rate paths for

Greece, Ireland, Portugal and Spain are persistently higher than their fitted "target" rates over much of simulation period. This is attributable to the fact that those countries had experienced relatively high inflation prior to joining the monetary union.

Overall, the counterfactual results for the "target" rates clearly reveal that the ECB monetary policy best reflects the economic conditions of its large member, namely Germany. The divergence between the fitted ECB "target" rate and the rate implied by a country's economic conditions is more pronounced for smaller euro area members. The results are supported by Huchet (2003), who finds asymmetric ECB policy effects among euro area members. Moreover, the findings in this subsection, which stand in contrast to the results for the *observed* policy rates in the preceding subsection, highlight the role of the interest rate smoothing behavior in monetary policy conduct.

4.3. Robustness Check

How robust are our empirical findings? To answer this question, we have replicated the estimation and counterfactual exercises with several modifications. First, instead of the Kalman filter, we have employed the standard HP filter and band pass filter to extract the trend component in the GDP series. In either case, the output gap is measured as the deviation of actual output from a nonlinear low-frequency trend component. Second, instead of a fixed window, we have performed recursive estimations using a rolling window of five years. Third, we have alternatively estimated the Taylor rule equation using contemporaneous and two-period-ahead data instead of one-period-ahead data for inflation. Overall, these alternative specifications have no appreciable effect on the results already presented.[7]

5. Conclusion

ECB officials have claimed that monetary policy decisions take into consideration the aggregate economic conditions of the euro area and disregard divergent national developments. Against this background, this paper has investigated the extent to which the ECB has responded to changing economic conditions of individual euro area member states versus the euro area as a whole. To this end, we first estimated a Taylor-type policy reaction function for euro area member states as well as for the euro area as a whole. The estimation results exhibit substantial disparities across countries, reflecting the extent of heterogeneity among the national economies inside the euro area.

We also conducted counterfactual exercises based on the estimated reaction functions to explore two alternative hypothetical scenarios. Under the hypothetical condition that the ECB responded to the economic conditions of individual euro area members, the "target" interest rates for most countries except Germany would have been quite different from those predicted by the area-wide data. This implies that the ECB policy rule best fits the economic conditions of the largest member state.

Similar results for Germany hold in the counterfactual exercises under an alternative hypothetical scenario that individual euro area member states were able to set their own policy rates. In this case, however, some smaller economies whose economic performance was similar to that of Germany were also found to have set interest rates near the "target" rates of the ECB. On the other hand, had other euro area member states followed their own policy rule, then their interest rates would have been quite different from those predicted by the ECB policy rule.

The extent of heterogeneity across national economies within the euro area entails a challenge for delegating the responsibility of monetary policy to the ECB. Our empirical findings prompt concerns about the efficacy of a single monetary policy in reacting to changing economic conditions of individual euro area member states. Because economies of euro area countries have been quite unsynchronized, ECB policy actions, which might be adequate for the euro area as a whole, might have been too loose for such faster growing countries as Greece and Ireland but too tight for slower growing countries, such as France.

Endnotes

[1] See Fernandez and Nikolsko-Rzhevsky (2007) for a recent comparison of different specifications of the Taylor rule.

[2] In May 2003, the ECB announced its revised monetary policy strategy that no longer explicitly assigned monetary growth a "prominent role" in its policy conduct (Carstensen, 2006).

[3] The Kalman filter recursive updating procedure is executed in a state-space representation, in which equation (4) is as the measurement equation and equation (5) the state equation.

[4] Euro area data refer to the evolving composition of the euro area. Data for periods prior to 2001 refer to EU11 (Austria, Belgium, Finland, Germany, Ireland, France, Italy, Luxembourg, the Netherlands, Portugal, and Spain). Data for periods between 2001 and 2005 refer to EU12 (EU11 plus Greece).

[5] Despite possible non-stationarity in the interest rate series, we follow the majority of the existing literature by specifying the interest rate variables in levels in order to compare our results with those in the literature. Alternatively, for interest rates identified with a unit-root (Finland and Ireland), we have followed Judd and Rudebusch (1998) and estimated the Taylor rule with an error-correction approach. The overall results are nevertheless the same as those reported here.

[6] For the first period (1999:1) in the dynamic projections, the actual value of i_{t-1} is used in place of the value of the lagged dependent variable, $\tilde{i}_{t-1}$, which does not exist.

[7] Detailed results in this subsection are not reported here for brevity, but are available upon request.

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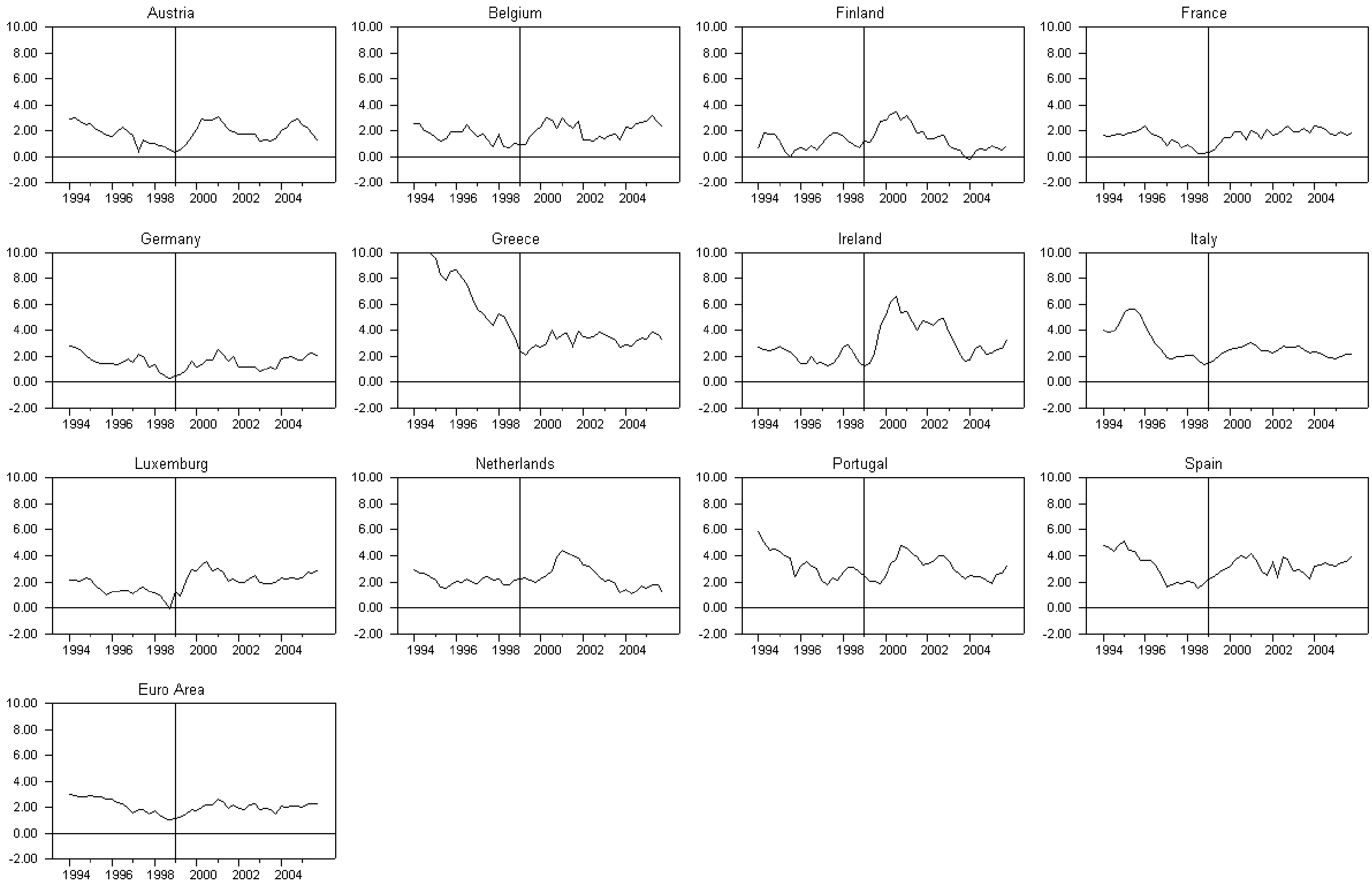
Table 1: GMM Estimation and Test Results, 1994-2005.

	Explanatory Variables									
	Lagged Interest	Intercept	Inflation	Output Gap	M3	SEE	*J*	*MeanF*	*SupF*	L_c
Austria	0.90 ***	4.25 ***	0.28	3.21 ***	-0.32 ***	0.24	7.72	4.49 *	11.51	1.61 **
	(48.56)	(5.61)	(0.80)	(8.14)	(3.77)					
Belgium	0.81 ***	3.49 ***	-0.20	2.54 ***	-0.06 *	0.29	7.02	4.87 **	14.21 *	2.37 ***
	(30.14)	(5.04)	(0.77)	(8.44)	(1.68)					
Finland	0.96 ***	-4.61 **	2.61 *	1.31 **	0.22 *	0.26	6.24	6.03 **	15.15 *	2.23 **
	(44.41)	(2.71)	(3.42)	(2.22)	(1.73)					
France	0.84 ***	6.52 ***	-1.15	5.53 ***	-0.35 ***	0.41	7.32	3.37	10.43	1.26 *
	(37.09)	(7.09)	(1.49)	(9.83)	(4.54)					
Germany	0.79 ***	2.24 ***	0.43 *	2.38 ***	-0.02	0.25	7.73	3.29 *	10.31	0.82
	(42.37)	(4.47)	(1.80)	(6.09)	(0.66)					
Greece	0.84 ***	-6.58 ***	2.76 ***	1.79 *		1.27	5.59	2.98	8.31	1.66 **
	(25.50)	(4.00)	(4.42)	(1.74)						
Ireland	0.96 ***	-12.54 **	5.01 ***	-4.70 ***		0.62	6.74	4.59 *	11.82	1.83 *
	(34.67)	(2.67)	(3.54)	(4.44)						
Italy	0.89 ***	-3.03 ***	2.62 ***	2.67 ***	-0.06	0.37	8.43	5.79 **	15.21 *	1.01
	(52.25)	(4.32)	(6.61)	(5.31)	(0.91)					
Luxembourg	0.79 ***	2.93 ***	0.50 **	0.86 **		0.36	7.92	7.24 ***	18.39 **	2.70 ***
	(17.41)	(2.89)	(1.98)	(2.12)						
Netherlands	0.97 ***	10.94 **	-1.17	16.52 ***	-0.51 **	0.48	5.86	3.63	12.21	1.74 **
	(29.19)	(2.47)	(1.13)	(6.41)	(2.23)					
Portugal	0.80 ***	-2.64 ***	0.97 **	-1.79 ***	0.60 ***	0.49	7.35	2.36	7.42	1.01 *
	(25.47)	(4.07)	(3.78)	(3.86)	(5.55)					
Spain	0.92 ***	-5.45 ***	4.32 ***	2.00 **	-0.72 ***	0.40	8.37	2.93 **	9.65 *	1.42 **
	(36.87)	(2.36)	(4.88)	(2.08)	(4.25)					
Euro Area	0.85 ***	2.98 **	1.39 **	1.38 **	-0.50 ***	0.33	7.21	2.51	7.72 **	1.39 *
	(21.93)	(3.03)	(2.27)	(2.38)	(3.21)					

Notes: Absolute *t*-statistics are in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1%, respectively.

Figure 1: Inflation Rates.



Note: Vertical gridlines indicate the formation of the ECB.

Figure 2: Recursive Coefficient Estimates.

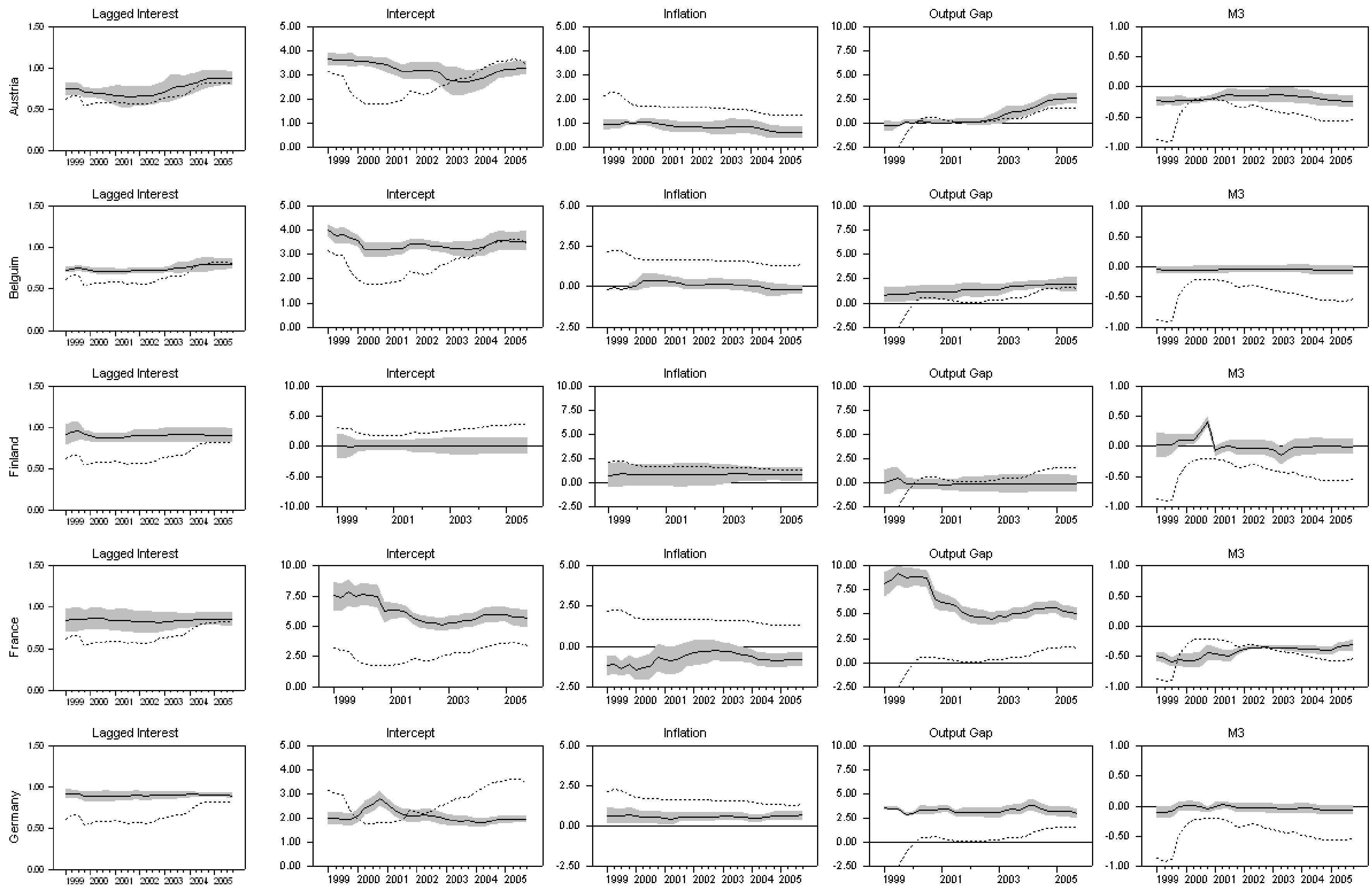


Figure 2 (continued).

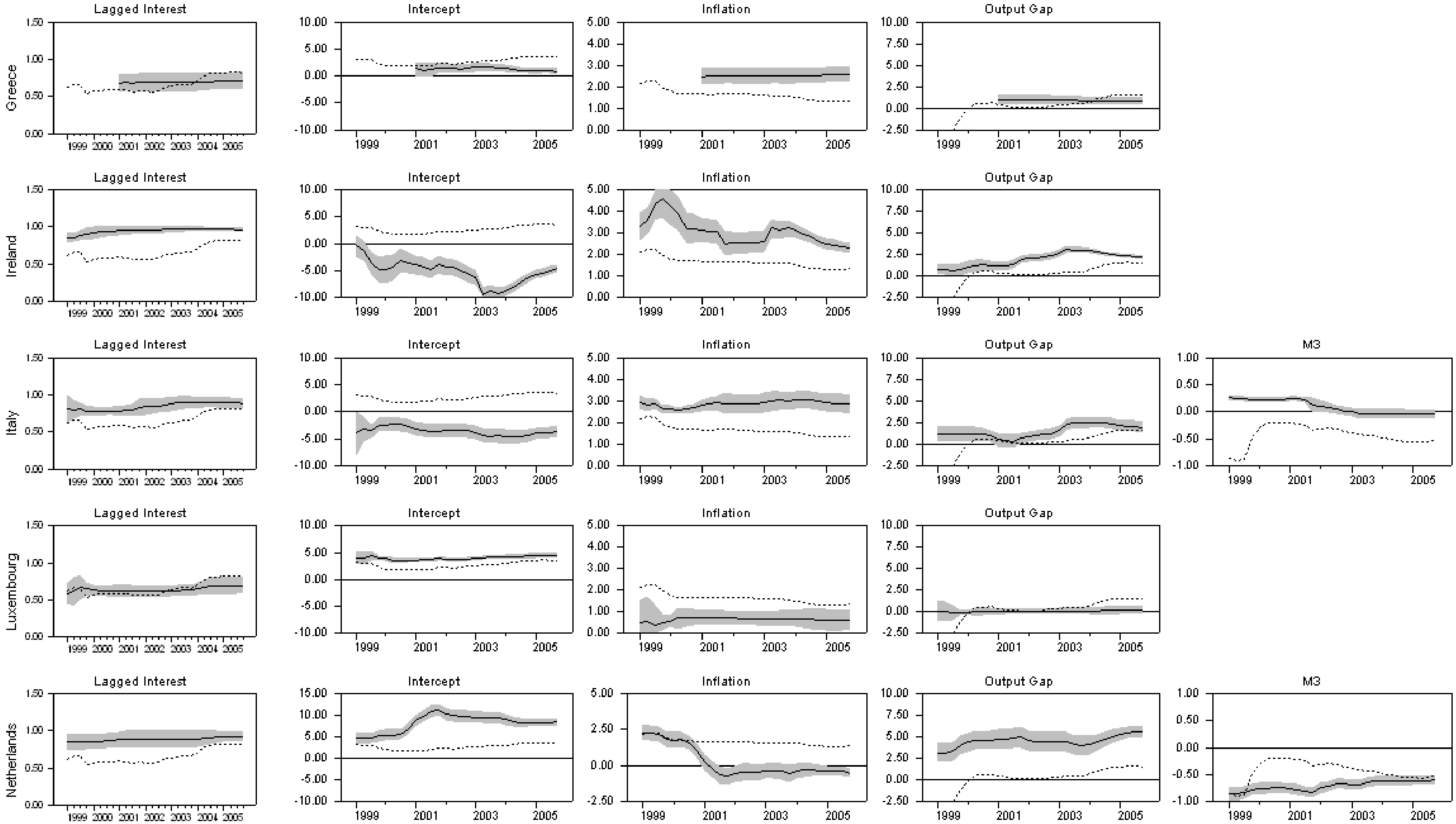
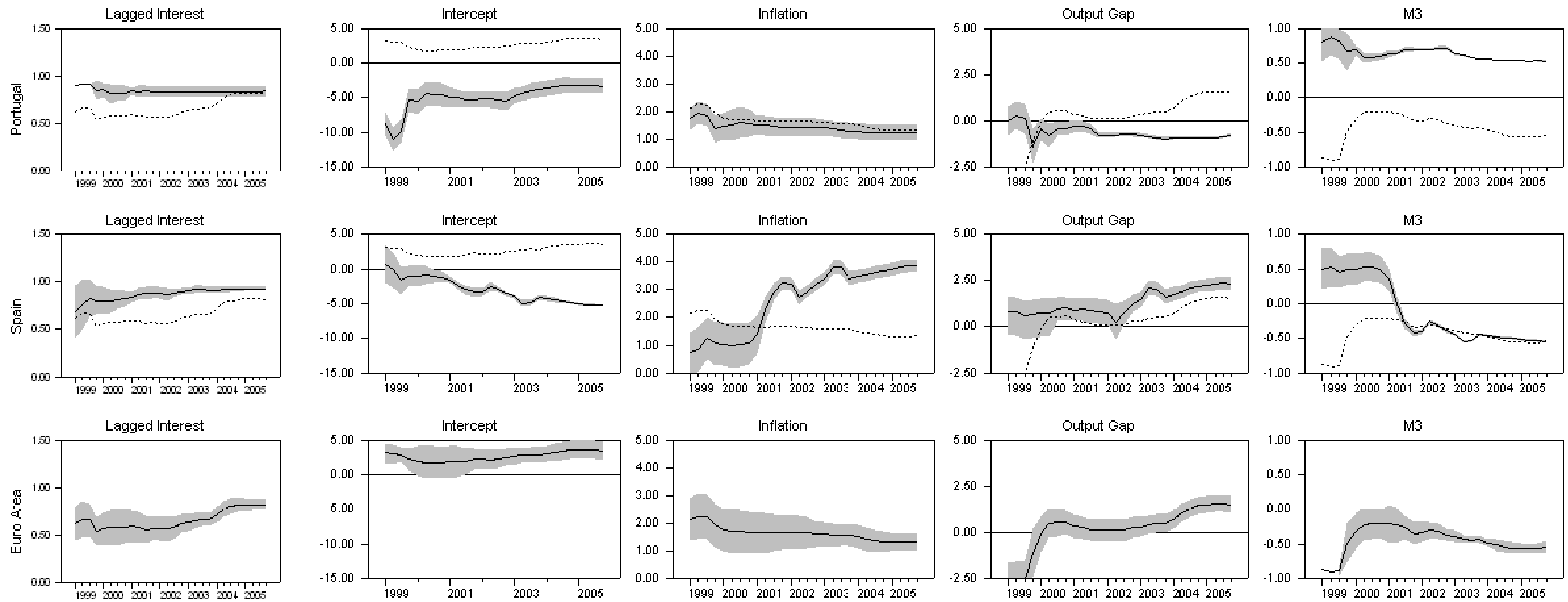
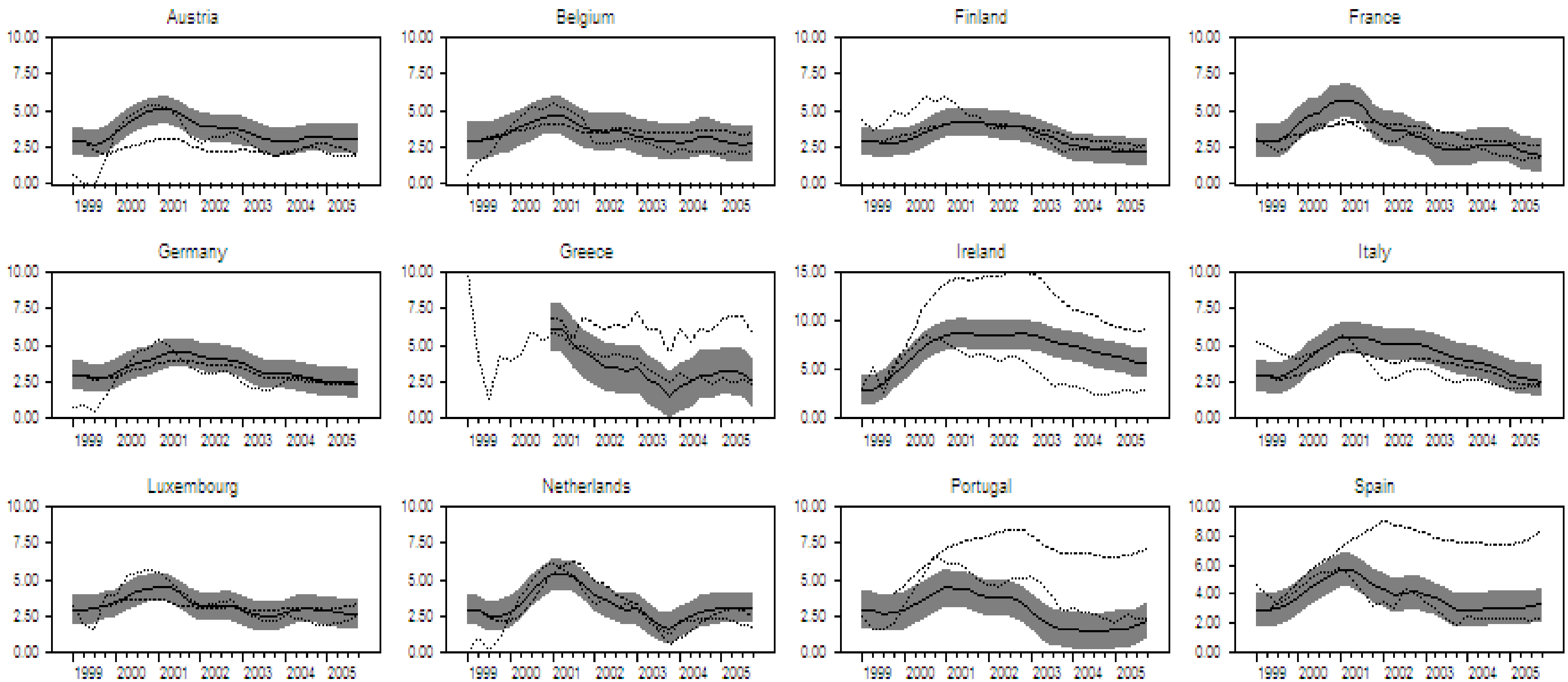


Figure 2 (continued)



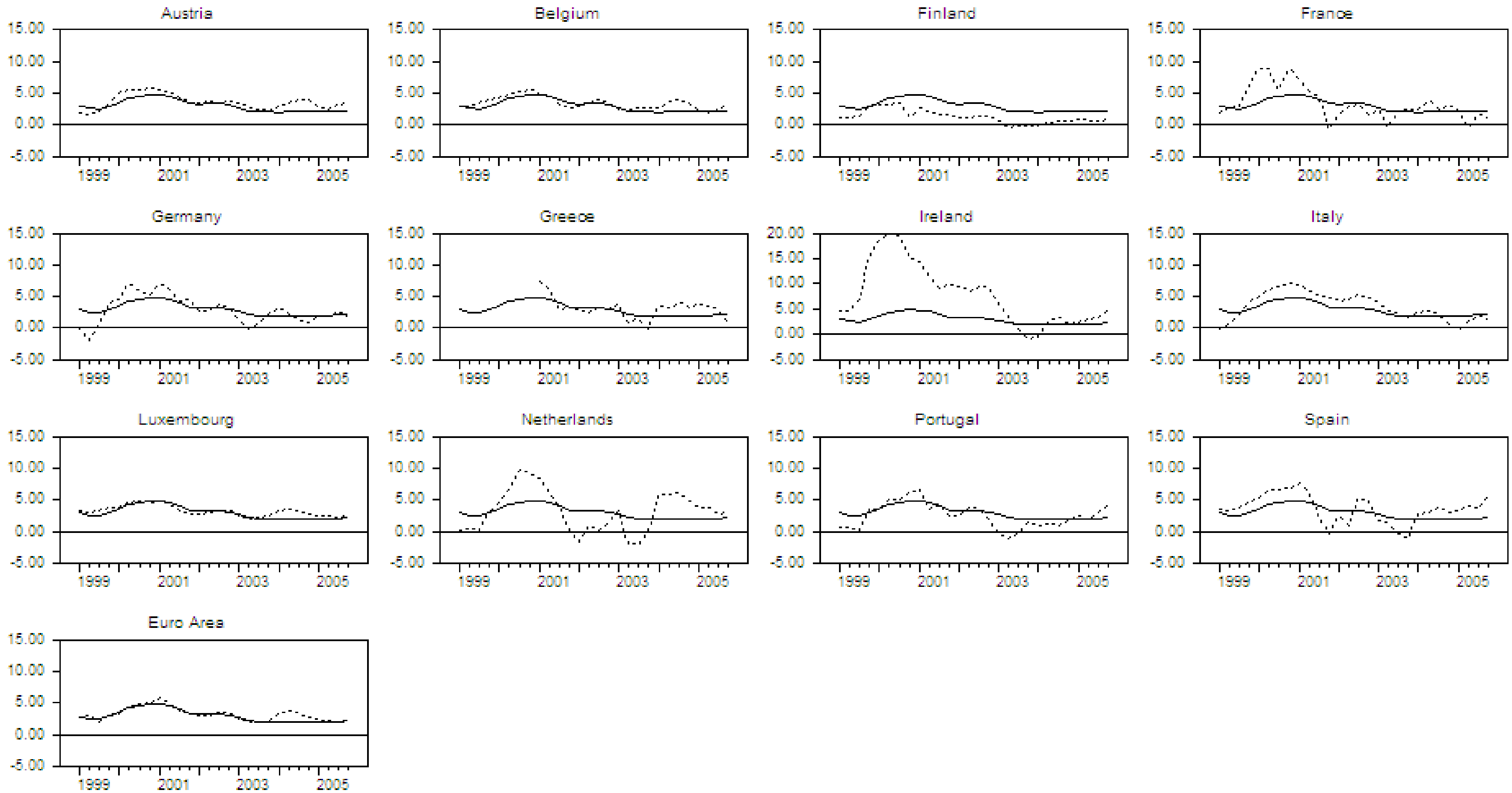
Notes: Dashed lines represent estimates for the euro area. Shaded areas are ± two standard error intervals around point estimates.

Figure 3: Counterfactual Results for Fitted Policy Rates.



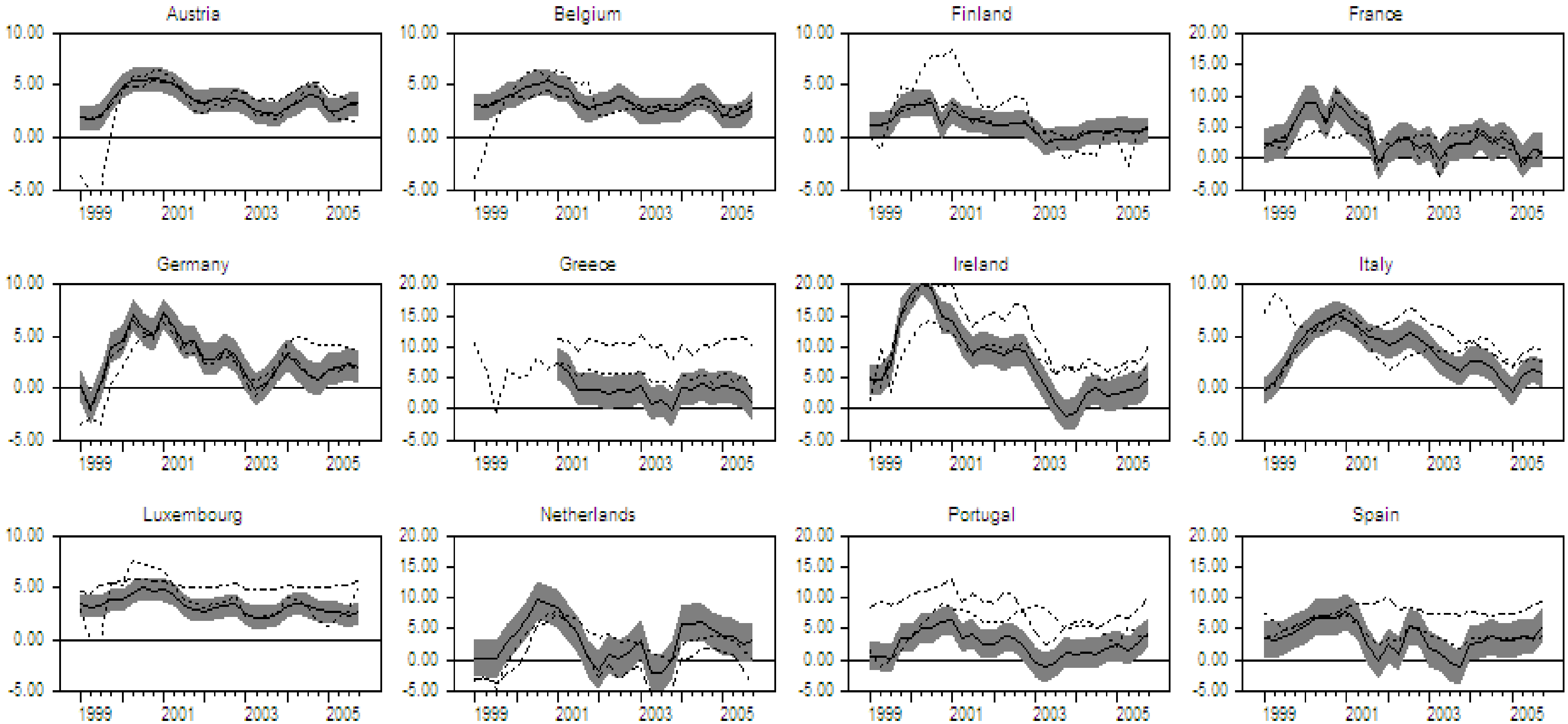
Notes: Solid lines represent the fitted policy rates, encapsulated in 95% confidence bands (shaded areas). Dotted lines (…) represent the counterfactual series projected by using the estimated Taylor rule for the ECB but data of individual euro area members. Dashed lines (- - -) represent the counterfactual series projected by using the estimated Taylor rules for the pre-euro sample but historical data for explanatory variables.

Figure 4: Actual Interest Rates and Fitted Target Rates.



Notes: Solid lines represent the actual policy rates. Dotted lines represent the fitted target rates.

Figure 5: Counterfactual Results for "Target" Interest Rates.



Notes: Solid lines represent the fitted "target" rates, encapsulated in 95% confidence bands (shaded areas). Dotted lines (…) represent the counterfactual series projected by using the estimated Taylor rule for the ECB but data of individual euro area members. Dashed lines (- - -) represent the counterfactual series projected by using the estimated Taylor rules for the pre-euro sample but historical data for explanatory variables.