

# Evaluating the Monetary Policy of the European Central Bank

Jim Lee  
Texas A&M University-Corpus Christi  
jim.lee@tamucc.edu

Patrick M. Crowley  
Texas A&M University-Corpus Christi  
patrick.crowley@tamucc.edu

January 2010

## Abstract

This paper employs alternative policy rules to empirically investigate the monetary policy conduct of the European Central Bank since 1999. According to the original Taylor rule with *a priori* fixed policy response coefficients, the ECB has been too accommodative, particularly during periods of economic expansion in the euro area. However, the actual policy path follows closely the two policy guidelines that are derived from the standard New Keynesian macroeconomic model. The empirical findings are robust to the use of real-time instead of revised data. There is some evidence of disparities in policy performance from the standpoints of individual member countries, highlighting one challenge of implementing monetary policy in the euro area with heterogeneous national economic conditions.

**JEL Classification:** E5, C5

**Keywords:** European Central Bank; Taylor rule; New Keynesian model; monetary policy

## **1. Introduction**

The European Central Bank (ECB) assumed responsibility for monetary policy of all members of the euro area in 1999. How well has the ECB performed over the past decade? Like most central banks, the ECB has confronted economic shocks over time. Since 1999, the euro area as a whole has undergone two widespread economic contractions—one that began in the early 2000s and another one that began in the late 2000s. Unlike many central banks, however, the ECB has also confronted a unique challenge stemming from heterogeneity across members of the euro area in a monetary union that has enlarged over time.

One controversial feature of the ECB's official stance is that its monetary policy decisions are reflective of the economic conditions of the euro area as a single economy rather than its individual constituent countries (Duisenberg, 2001). However, recent studies (e.g., Brissimis and Skotida, 2008; Jondeau and Sahuc, 2008a,b; Lee, 2009; Lee and Crowley, 2009) show welfare losses of varying degrees if monetary policy ignores country-specific idiosyncrasies within the region. In this light, monetary policy in the euro area should also be evaluated from the perspective of its member countries in addition to the region as a whole.

A popular way of analyzing monetary policy is to compare the actual policy behavior with the prescriptions based on a Taylor rule. A Taylor rule describes a central bank's policy instrument as a systematic response to changes in inflation and output. Recently, Billi (2009) used two versions of the Taylor rule to evaluate whether the monetary policy stance of Japan and the U.S. was appropriate during some deflationary episodes. In this paper, we employ a similar empirical strategy to analyze the ECB monetary policy over the central bank's 10-year history between 1999 and 2009.

The rest of this paper proceeds as follows. The second section provides an overview of three policy rules as alternative guidelines for evaluating the monetary policy behavior of the ECB. The third section presents the empirical results. The fourth section concludes the paper.

## 2. Policy Rules

### 2.1. Original Taylor Rule

In the seminal work of Taylor (1993), a central bank sets its policy instrument in response to changes in inflation and output. Such a policy instrument rule or reaction function takes the form:

$$i_t = i^* + \phi_\pi(\pi_t - \pi^*) + \phi_y y_t \quad (1)$$

where  $i_t$  is the level of the policy rate in period  $t$ . Three factors determine the policy rate, which is a short-term nominal interest rate, such as the overnight lending rate. The first factor is the equilibrium nominal interest rate  $i^*$ , which is the sum of the equilibrium real interest rate and the central bank's inflation target,  $r + \pi^*$ .<sup>1</sup> The second factor is the deviation of the actual inflation rate from the central bank's desired level of inflation,  $\pi_t - \pi^*$ . The third factor is the output gap,  $y_t$ , which is the level of real output above its potential level.

When inflation rises above the inflation goal or real output rises above potential, policymakers tighten monetary policy by raising the policy rate. A tight monetary policy reduces inflation and output by reducing aggregate demand. Conversely, when inflation is too low or real output is below potential, the Taylor rule prescribes an easy monetary policy by lowering the policy rate. In other words, the policy response coefficients,  $\phi_\pi$  and  $\phi_y$ , are both positive.

Taylor (1993) shows that his policy guideline describes the historical policy behavior of the Federal Reserve well, as captured by the federal funds rate. In particular, he suggests that the coefficient on the inflation gap be set at 1.5 and the coefficient on the output gap be set at 0.5. Moreover, the equilibrium nominal interest rate is assumed to be 4 percent and both the equilibrium real interest rate and the inflation goal are assumed to be 2 percent.

The original formulation of the Taylor rule (1) has been modified to better reflect monetary policy in practice (e.g., Clarida *et al.*, 1998; Koenig, 2004). One such modification is replacing *actual* inflation on the right hand side of the Taylor-rule equation with *expected* inflation or inflation forecasts. This captures the forward-looking nature of monetary policy decisions. Another major modification is adding one or more lagged values of the policy rate on the right hand side of the Taylor rule. This reflects the gradual manner in which central banks adjust their policy instruments in response to new economic developments, or the so-called interest rate smoothing behavior. Despite its seemingly *ad hoc* nature and simplicity, the original Taylor rule and its variants have proven to be reasonably good descriptions of how major central banks around the world operate (e.g., Clarida *et al.*, 1998).

## 2.2. *Optimal Policy Rule*

Taylor (1993) formulated his policy rule in light of the monetary policy behavior of the Federal Reserve during the period from 1987 to 1992. There is no reason to believe that this same formulation with *a priori* fixed coefficients for the inflation and output terms to also serve adequately as a policy guide for other central banks like the ECB and for other periods. Given this limitation of the original Taylor rule, we follow recent studies (e.g., Clarida *et al.*, 1999; Svensson, 1999; Rudebusch, 2005; Billi, 2009) that formulate a Taylor-type policy instrument

rule as the outcome of an optimization problem, in which policymakers minimize a given loss function subject to the constraints that reflect the structure of the macroeconomy. The key distinction between this “optimal” Taylor rule and the “original” Taylor rule boils down to the numerical values of the response coefficients,  $\phi_\pi$  and  $\phi_y$ .

It has become common practice (e.g., Clarida *et al.*, 1999; Svensson, 1999; Rudebusch, 2005) to assume that a typical central bank aims at minimizing the variability of inflation and output in an economy. The central bank’s objectives can therefore be expressed in terms of a welfare loss function in the form:

$$\min E_t \sum_{\tau=0}^{\infty} \alpha^\tau [(\pi_{t+\tau} - \pi^*)^2 + \lambda_y y_{t+\tau}^2 + \lambda_i i_{t+\tau}^2] \quad (2)$$

where  $E_t$  denotes the expectation conditional on information available in period  $t$ . The first two terms in the brackets reflect the dual policy objectives of a typical central bank today—inflation stabilization and output stabilization. The coefficient  $\lambda_y$  reflects policymakers’ aversion to output deviations from potential output. Similarly, the coefficient  $\lambda_i$  reflects policymakers’ aversion to large changes in the policy rate  $i_t$ , as observed by Sack and Wieland (2000), among others. In equation (2), the welfare loss from deviations of inflation around the inflation goal  $\pi^*$  is normalized to one, such that the two unknown coefficients in the equation,  $\lambda_y$  and  $\lambda_i$ , are expressed in relative terms. The coefficient  $\alpha$  is the time discount factor.

In recent decades, the New Keynesian model has emerged as a popular workhorse for understanding the evolution of an economy and for analyzing monetary policy (e.g., Giannoni and Woodford, 2003; Woodford, 2003). The standard version of the New Keynesian model embodies two equations. The first equation is essentially a forward-looking version of the Phillips curve relationship:

$$\pi_t = \alpha E_t \pi_{t+1} + \delta y_t + \omega_t. \quad (3)$$

Equation (3) relates current inflation positively to both expected future inflation  $E_t \pi_{t+1}$  and the current output gap  $y_t$ .<sup>2</sup> The first term reflects the forward-looking element of the Phillips curve that is consistent with the staggered pricing feature of the Calvo (1983) framework, in which only a given fraction of firms adjust their prices in any given period. In this case, a higher expected future inflation induces firms to raise prices by more. The second term of the equation captures the extent to which excess demand affects price movements. Equation (3) can also be interpreted as the aggregate supply curve so that  $\omega_t$  represents an aggregate supply shock. Several studies (e.g., Galí and Gertler, 1999; Galí, Gertler and López-Salido, 2005; Jondeau and Bihan, 2005; Smets and Wouters 2007) find that the forward-looking Phillips curve specification provides a reasonably good representation of inflation dynamics in U.S. and European countries.

The second equation of the New Keynesian model is basically a forward-looking aggregate demand curve:

$$y_t = E_t y_{t+1} - \beta(i_t - E_t \pi_{t+1}) + v_t. \quad (4)$$

According to Clarida *et al.* (1999), equation (4) can be derived from a standard Euler equation for consumption along with a relevant market clearing condition. This expression incorporates the concept of consumption smoothing into the aggregate demand curve by relating the output gap positively to the expected future output gap and negatively to the *ex ante* real interest rate,  $i_t - E_t \pi_{t+1}$ . As aggregate demand depends on changes in consumer preferences and potential output is affected by technology shocks, the term  $v_t$  captures these shocks and other temporary factors.

Given the above model that describes the macroeconomic environment, the design of an optimal monetary policy rule amounts to manipulating the policy rate in order to solve a dynamic optimization problem that minimizes the loss function of equation (2) subject to the constraints represented by equations (3) and (4). Under commitment, the first-order conditions of the central bank's optimization problem are as follows (see Lee, 2009):

$$\alpha(E\pi_{t+1} - \pi^*) + \alpha(E_t\phi_{t+1} - \phi_t) - \beta\psi_t = 0, \quad (5)$$

$$\alpha\lambda_y E_t y_{t+1} - \alpha\delta E_t \phi_{t+1} - \psi_t + \alpha E_t \psi_{t+1} = 0, \quad (6)$$

$$\lambda_t i_t + \beta\psi_t = 0. \quad (7)$$

where  $\phi_{t+i}$  and  $\psi_{t+i}$  are the Lagrange multipliers associated with the constraints captured by the Phillips curve equation (3) and the aggregate demand equation (4), respectively. The evolution of the policy rate that satisfies this dynamic optimization problem can be expressed as:

$$i_t = \theta_\pi (\pi_t - \pi^*) + \theta_y (y_t - y_{t-1}) + \varphi_1 i_{t-1} + \varphi_2 i_{t-2} \quad (8)$$

where  $\theta_\pi = \delta\beta / \lambda_t$ ,  $\theta_y = \lambda_y \beta / \lambda_t$ ,  $\varphi_1 = [1 + (1/\alpha) + (\delta\beta/\alpha)]$ , and  $\varphi_2 = -1/\alpha$ . Svensson (1999) shows that this policy rule with “structural” parameters derived from the New Keynesian model closely resembles the reduced-form specification of the simple Taylor rule in equation (1). The key differences are the lag values of the output gap and interest rate terms that reflect policymakers' preferences for a gradual movement in the policy rate.

Following Ireland (2004), we solve this New Keynesian monetary model by first writing equations (3), (4), (5), (6) and (7) into the state-space form, which represents a linear rational expectation system. The system of equations is then solved numerically under the assumption of policy commitment.<sup>3</sup> In the estimated models, we assume the inflation goal of the ECB,  $\pi^*$ , to be 2 percent annually. This assumption is consistent with the central bank's expressed

preference for achieving price stability, which is defined by its officials as an inflation rate below 2% over the median term (ECB, 1998, 2003). Lee (2009) confirms that this numerical goal is close to the ECB's implicit inflation target that is estimated from a New Keynesian monetary model.

Table 1 shows the model estimation results. Overall, the values are comparable to those employed by Billie (2009) for his study of monetary policy in the U.S. and Japan. The second column of Table 1 shows the coefficient estimates based on the aggregate data of the euro area. The other columns show the estimation results based on the inflation and output data of the individual member countries, while the policy rate equals the ECB policy rate for the euro area as a whole. The estimates for  $\alpha$  suggest high degrees of price stickiness for all countries. In addition, the estimates for  $\delta$  offer evidence of a rather flat Phillips curve in Europe.

Similarly, the estimates for  $\beta$  suggest that the slope of the aggregate demand curve is quite flat in most cases, although the magnitudes vary across countries. These findings for slopes of the Phillips curve and the aggregate demand curve are comparable to the findings for the euro area in recent studies (e.g., Leith and Malley, 2005; Brissimis and Skotida, 2008; Lee, 2009).

Overall, the estimates for the ECB's weights on output and interest rate stabilization,  $\lambda_y$  and  $\lambda_r$ , are low relative to the weight on inflation, which is set to 1. The particular estimates for the euro area highlight the ECB's primary objective of price stabilization. However, the estimated weights on output and interest rate stabilization are noticeably high for such countries as Ireland and Portugal, both of which experienced relatively high inflation compared with other euro area member states during the first decade of the ECB.



## 2.2. *Optimal Taylor Rule*

In addition to the optimal policy rule derived entirely from the New Keynesian framework, we also consider the design of an instrument rule based on the simple Taylor rule of equation (1) instead of equation (8). Following Billi (2009), we derive such an “optimal” Taylor-type policy rule by finding the response coefficients in equation (1) that close the model. In addition to the original Taylor rule with *a priori* fixed response coefficients, we include this Taylor-type policy rule due to its popularity. The path of the interest rate in this policy rule is generated by first calibrating the New Keynesian model. We derive the numerical values in calibration from the model estimates presented in Table 1.

Table 2 compares the policy response coefficients on the current values of the inflation gap and output gap based on the alternative policy rules for the euro area.<sup>4</sup> For the coefficients in the original Taylor rules, the respective values for  $\phi_x$  and  $\phi_y$  used are those recommended by Taylor (1993). The corresponding values for the optimal Taylor rule and the implicit policy rule are derived from estimating the New Keynesian model. The values of the policy response coefficients are comparable to those reported in recent studies for central banks (e.g., Woodford, 2003). The New Keynesian model generates values close to 1 for the response coefficients on the inflation gap, so that these numerical values are about one-third smaller than the value of 1.5 for the original Taylor rule. On the other hand, the response coefficients on the current output gap term are comparable between the policy rules based on the New Keynesian model and the original Taylor rule. The optimal Taylor rule generates a slightly higher policy response to the current output gap than the other policy rules do.

### 3. Empirical Results

#### 3.1. Data

The observation period spans from 1999 to 2009 using quarterly data sourced from the OECD's *Main Economic Indicators* database and the ECB's official website. Today, the euro area consists of 16 member countries, including the 11 original stage three members of the EMU, Greece (joining in 2001), Slovenia (joining in 2007), Cyprus and Malta (both joining in 2008), and Slovakia (joining in 2009). For individual members of the euro area, we look at the first 12 member states, excluding the new members of Slovenia, Cyprus, Malta and Slovakia.<sup>5</sup>

The specification of data for the euro area and its members is described in detail by Lee (2009). The ECB policy rate is measured by the 3-month Euribor rate, which is also the policy rate for all members of the euro area after they turned over the responsibility of monetary policy to the ECB in 1999. Inflation is measured by the annualized percent change in the Harmonized Index of Consumer Prices (HICP). Aggregate inflation data for the euro-area as a whole are constructed as the weighted average of the 12 member states where the weights for individual countries are the relative sizes of real GDP. Output is measured by real GDP. The area-wide output data are constructed as the sum of real GDP in the 12 member states. The output gap is the difference between actual GDP and potential GDP as a percent of potential GDP. According to the OECD (2008), its potential GDP data are estimates consistent with the levels of output that an economy can produce at a constant inflation rate.

Figure 1 displays the inflation and output gap data for the euro area as a whole. The upper panel reveals that inflation stayed around two percent before rising to about four percent in 2008 and then falling to nearly zero percent in 2009. In the lower panel, real GDP (revised data) was above its potential level in early 2000s and the two-year period before mid-2008, when

much of Europe and the rest of the developed world began to fall into a severe recession. The rapid fall in inflation in 2009 corresponds to the extraordinary widening in the recessionary gap.

### 3.2. Evidence from Policy Rules

In this subsection, we explore whether the ECB monetary policy has been appropriate during its 11-year history in light of several policy guidelines: the original Taylor rule with *a priori* fixed policy response coefficients, the “optimal” Taylor rule calibrated within the New Keynesian model, and the optimal policy rule derived from the same New Keynesian model.<sup>6</sup> Figure 2 compares the actual policy of the ECB with the alternative policy rules generated from the aggregate euro area data. One striking observation is the appreciable discrepancy between the ECB policy path and the path implied by the original Taylor rule. Except for the period when there was an economic downturn in the euro area after mid-2008, the original Taylor rule implies that the ECB monetary policy was too accommodative. Similarly, Sauer and Sturm (2007), and Lee and Crowley (2009) have found that the ECB was too loose in responding to changes in inflation when its policy conduct is judged in light of a simple Taylor rule similar to ours.

Other than the forward-looking feature, Taylor’s (1993) original formulation of the policy guideline may not be particularly appropriate for evaluating the behavior of the ECB in the most recent decade. Indeed, the actual policy rate over time is quite close to the guidelines set by the “optimal” Taylor rule and the “implicit” policy rule, both of which are derived from the New Keynesian model. As compared to the path of the optimal Taylor rule, the path of the “implicit” policy rule shows a higher degree of interest rate smoothing as it incorporates the central bank’s preference for interest rate stabilization. The actual policy path shows no sizable deviations from

either of the two model-based policy guidelines. Over much of the observation period, the path of the actual policy rate is contained within a 90 percent confidence interval for the path derived from the implicit policy rule. The confidence interval around the path of the implicit policy rule, which is the band filled with squares, is constructed using a standard bootstrapping method (500 replications) with the calibrated New Keynesian model.

Instead of the aggregate euro area data, Figure 3 compares the actual policy against the policy guidelines derived from data of individual member countries. While the patterns of the individual plots overall are similar to those for the euro area in Figure 2, there is evidence of asymmetries across countries. For the major “core” members—France and Germany—the ECB policy was remarkably close to the guidelines set by the original Taylor rule. By contrast, the ECB policy was considered too accommodative for Greece and Ireland, which experienced relatively high inflation during the early part of the period.

The results for most member states are similar to the results based on the aggregate euro area data, with the two policy guidelines generated by the New Keynesian model being remarkably close to each other. However, there are more noticeable deviations of the path of actual policy from the path of the optimal Taylor rule than from the path of the implicit policy rule. For instance, during the economic downturn across Europe in 2001, the actual policy rates were above the rates of the optimal Taylor rule for most member states except the Netherlands and Portugal. On the contrary, during the expansionary period between 2001 and 2007, ECB monetary policy appears to be too accommodative in light of the optimal Taylor rule for the majority of member countries, except Finland and the Netherlands. For Greece, Ireland and Spain between 2003 and 2005, the actual policy rates were noticeably above what the optimal Taylor rule calls for. From the standpoint of the implicit policy rule generated entirely from the

New Keynesian model, however, the ECB has played an adequate role in responding to changes in inflation and output over time.

As for the euro area as a whole, the historical behavior of the ECB monetary policy is remarkably close to the policy guidelines implied by the New Keynesian model calibrated for individual member countries. The major distinction between the “implicit” policy rule and the Taylor-type policy rules is the interest rate smoothing dynamic that reflects the central bank’s aversion to interest rate variability. The results in Figures 2 and 3, therefore, highlight the extent of inertia in monetary policy decisions. When such inertia is taken into consideration, the ECB’s monetary policy conduct is considered to be adequate in responding to the changing economic conditions during its relatively short history of operation.

A growing literature (e.g., Camacho *et al.*, 2006; De Haan *et al.*, 2008; Jondeau and Sahuc, 2008b) emphasizes the potential implication of cross-country heterogeneity for monetary policy in the euro area. Some studies (e.g., Huchet, 2000) also find asymmetries in ECB policy effects across euro-area members. In contrast to those studies, the policy guidelines based on the standard New Keynesian model suggest that the ECB policy since 1999 has been quite appropriate in responding to new developments in the euro area as a whole as well as the majority of its member countries. Nevertheless, for some countries with relatively high inflation, such as Greece and Ireland, evidence supports that monetary policy for the euro area as a whole might have been too accommodative.

### *3.3. Policy Rules with Real-Time Data*

We have evaluated the ECB monetary policy based on the revised data available today. However, the data of current vintage have undergone several revisions. Orphanides (2001)

shows that estimation of monetary policy responses with *ex post* revised data would yield misleading inferences on the historical patterns of policy conduct. As the objective of this paper is to investigate monetary policy decisions made in real time, we consider a set of real-time output data instead of data of current vintage. The real-time data for a given period should reflect only the information available to economic agents and policymakers in that period when they make economic or policy decisions. The vintage of the real-time data for each period corresponds to the latest data released by the OECD during that period. To do so, we look into the MEI's Real-Time Database and collect the output (GDP) gap data that were released no later than the period in which expectations or decisions were made. The inflation data were originally available on a monthly basis and most revisions would have been made before the subsequent quarter passes.<sup>7</sup> The interest rate data were not subject to revisions. For illustration, we superimposed in Figure 1 the GDP gap series based on the real-time data over the series based on revised data. The two output series are almost identical until 2006. Beginning 2006, the absolute size of the GDP gap was much greater in the case of the series with revised data, implying that the initial data releases underestimated the relatively large fluctuations in real GDP.

Corresponding to Figure 2, Figure 4 compares the actual policy path with the alternative policy guidelines based on the real-time data for the euro area. It is obvious that the original policy rule generates an interest rate path that is closer to all other interest rate paths when it is estimated with real-time data than revised data. However, the real-time data generate no remarkable differences for the paths of other policy rules between the two types of data. One notable observation is the period beginning 2007, in which the optimal Taylor rule implies more aggressive responses to the economic downturn. Similar to the results for the euro area as a

whole, the overall findings about monetary policy performance from the standpoints of the individual member states remain unaltered when real-time instead of revised data are used.

#### **4. Conclusion**

In this paper, we have used alternative policy rules to evaluate the monetary policy conduct of the ECB. According to the original Taylor policy rule, monetary policy was too accommodative throughout much of the history of the ECB, particularly during periods of economic expansion. However, there are negligible deviations of the actual policy path from the two policy rules derived from the standard New Keynesian model that incorporates forward-looking behavior. To the extent that the New Keynesian framework provides a reasonable representation of the euro-area economy, the ECB monetary policy has been quite appropriate in responding to the changing economic conditions in the euro area, especially over the periods of an economic downturn. Actual monetary policy follows closest the model-based policy rule that also incorporates some inertia in policy decisions.

Even though monetary policy is found to be appropriate for the euro area as a whole, there is evidence of disparities from the standpoints of individual member countries. In particular, the ECB appeared to have reacted more aggressively to changing economic conditions in the major “core” members, such as France and Germany. On the other hand, monetary policy was too loose for some “peripheral” countries, such as Ireland and Portugal, which experienced relatively high inflation at times. This contrast highlights one of the challenges in implementing monetary policy for a region with heterogeneous national economic conditions. The design of a common monetary policy for all members of the euro area should take into account the implications of this factor.

## Endnotes

- <sup>1</sup> For simplicity, we assume the variables with an asterisk to be constant over time in our empirical work. However, the equilibrium real interest rate can be affected by such long-term factors as changes in productivity. Similarly, central banks can change its inflation goal.
- <sup>2</sup> To account for price stickiness, some studies (e.g., Rudebusch, 2005) also consider a so-called hybrid version of the Phillips curve by adding a lagged inflation term. Those results are not presented here because they are overall similar to those presented in this paper.
- <sup>3</sup> See Lee (2009) for more details about this estimation method.
- <sup>4</sup> The response coefficients satisfy the conditions for the Taylor principle, which requires that  $\phi_x + \phi_y(1 - \alpha)/(4\delta) > 1$ . The patterns of response coefficients based on the models of individual countries are similar to those for the euro area as a whole and, therefore, are not reported here to save space.
- <sup>5</sup> Given the fact that Greece did not become a member of the euro area until 2001, we have replicated all estimations over an estimation period beginning 2001:I. The results are comparable to those reported in this paper. This is attributable the relatively small size (2%) of the Greek economy in the euro area.
- <sup>6</sup> Because there is no consensus regarding how optimal policy are formulated, the Taylor rules and the policy rules implied by the simple New Keynesian model do face some limitations as guidelines for evaluating monetary policy. See Billi (2009) and others for detailed discussions of their limitations. In our study, the results from alternative policy rules potentially shed light on the robustness of our findings.
- <sup>7</sup> While it is difficult to ascertain whether data published in a given quarter are available to policymakers before but not after they make policy decisions within that same quarter, the use



of the real-time data for analyzing monetary policy behavior is an improvement over the use of data that are subsequently revised multiple times. Nevertheless, despite sizable differences between originally released and revised data, the data series are highly correlated (with an average simple correlation of over 0.9).

## References

- Billi, Roberto M. “Was Monetary Policy Optimal During Past Deflation Scares?” Federal Reserve Bank of Kansas City, *Economic Review*, third quarter, 2009, 67-98.
- Brissimis, Sophocles, and Ifigeneia Skotida. “Optimal Monetary Policy in the Euro Area in the Presence of Heterogeneity,” *Journal of International Money and Finance*, 2008, 27(2), 209-226.
- Calvo, Guillermo. “Staggered Prices in a Utility-Maximizing Framework,” *Journal of Monetary Economics*, 1983, 12(3), 383-398.
- Camacho, M., G. Perez-Quiros, and L. Saiz. “Are European Business Cycles Close Enough to be Just One?” *Journal of Economics Dynamics and Control*, 2006, 30, 1687-1706.
- Clarida, Richard, Jordi Galí, and Mark Gertler. “Monetary Policy Rules in Practice: Some International Evidence,” *European Economic Review*, 1998, 42, 1033-1067.
- Clarida, Richard, Jordi Galí, and Mark Gertler. “The Science of Monetary Policy: A New Keynesian Perspective,” *Journal of Economic Literature*, 1999, 37, 1661-1707.
- De Haan, Jakob, Robert Inklaar, and Richard Jong-A-Pin. “Will Business Cycles in the Euro Area Converge? A Critical Survey of Empirical Research,” *Journal of Economic Surveys*, 2008, 22(2), 234-273.
- Duisenberg, Willem. “Some Remarks on the Euro in a U.S. Context,” Speech by Dr. Willem F. Duisenberg, President of the European Central Bank, at a breakfast meeting of the Council on Foreign Relations, New York, April 19, 2001.
- European Central Bank. “A Stability-Oriented Monetary Policy Strategy for the ESCB,” European Central Bank Press Release, October 13, 1998.

European Central Bank. "The ECB's Monetary Policy Strategy," European Central Bank Press Release, May 8, 2003.

Galí, Jordi and Mark Gertler. "Inflation Dynamics: A Structural Econometric Analysis," *Journal of Monetary Economics*, 1999, 44, 195-222.

Galí, Jordi, Mark Gertler, and David López-Salido. "Robustness of the Estimates of the Hybrid New Keynesian Phillips Curve," *Journal of Monetary Economics*, 2005, 52(6), 1107-1118.

Giannoni, Marc P., and Michael Woodford. "How Forward-Looking is Optimal Monetary Policy?," *Journal of Money, Credit, and Banking*, 2003, 35, 1425-1469.

Huchet, Marilyne. "Does Single Monetary Policy Have Asymmetric Real Effects in EMU," *Journal of Policy Modeling*, 2000, 25, 151-178.

Ireland, Peter N. "A Method for Taking Models to the Data," *Journal of Economic Dynamics and Control*, 2004, 28(6), 1205-1226.

Jondeau, Eric, and Hervé Le Bihan. "Testing for the New Keynesian Phillips Curve: Additional International Evidence," *Economic Modelling*, 2005, 22, 521-550.

Jondeau, Eric, and Jean-Guillaume Sahuc. "Optimal Monetary Policy in an Estimated DSGE Model of the Euro Area with Cross-country Heterogeneity," *International Journal of Central Banking*, 2008a, 4(6), 23-70.

\_\_\_\_\_. "Testing Heterogeneity within the Euro Area," *Economics Letters*, 2008b, 99, 192-196.

Koenig, Evan. F. "Monetary Policy Prospects," Federal Reserve Bank of Dallas, *Economic and Financial Policy Review*, 3(2), 2004.

Lee, Jim. "Evaluating Monetary Policy of the Euro Area with Cross-Country Heterogeneity: Evidence from a New Keynesian Model," *Economic Systems*, 2009, 33(4), 325-343.

- Lee, Jim, and Patrick M. Crowley. "Evaluating the Stresses from ECB Monetary Policy in the Euro Area," *Bank of Finland Research Discussion Papers*, 2009, No. 11/2009.
- Leith, C., and J. Malley. "Estimated General Equilibrium Models for the Evaluation of Monetary Policy in the US and Europe," *European Economic Review*, 2005, 49(8), 2137-2159.
- OECD. (2008) "Revisions of Quarterly Output Gap Estimates for 15 OECD Member Countries."
- Orphanides, Athanasios. "Monetary Policy Rules Based on Real-Time Data," *American Economic Review*, 2001, 91(4), 964-985
- Rudebusch, Glenn D. "Assessing the Lucas Critique in Monetary Policy Models," *Journal of Money, Credit and Banking*, 2005, 37(2), 245-272.
- Sack, Brian, and Volker Wieland. "Interest-Rate Smoothing and Optimal Monetary Policy: A Review of Recent Empirical Evidence," *Journal of Economics and Business*, 2000, 52, 205-228.
- Sauer, Stephan, and Jan-Egbert Sturm. "Using Taylor Rules to Understand European Central Bank Monetary Policy," *German Economic Review*, 2007, 8(3), 375-398.
- Smets, Frank and Raf Wouters. "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach," *American Economic Review*, 2007, 97, 586-606.
- Svensson, Lars E. O. "Monetary Policy Issues for the Eurosystem," NBER Working Papers No. 7177, 1999.
- Taylor, John B. "Discretion versus Policy Rules in Practice," *Carnegie-Rochester Conference Series on Public Policy*, 1993, 39, 195-214.
- Woodford, M. *Interest and Prices, Foundations of a Theory of Monetary Policy*. Princeton, NJ: Princeton University Press, 2003.



**Table 1. New Keynesian Model Estimation Results.**

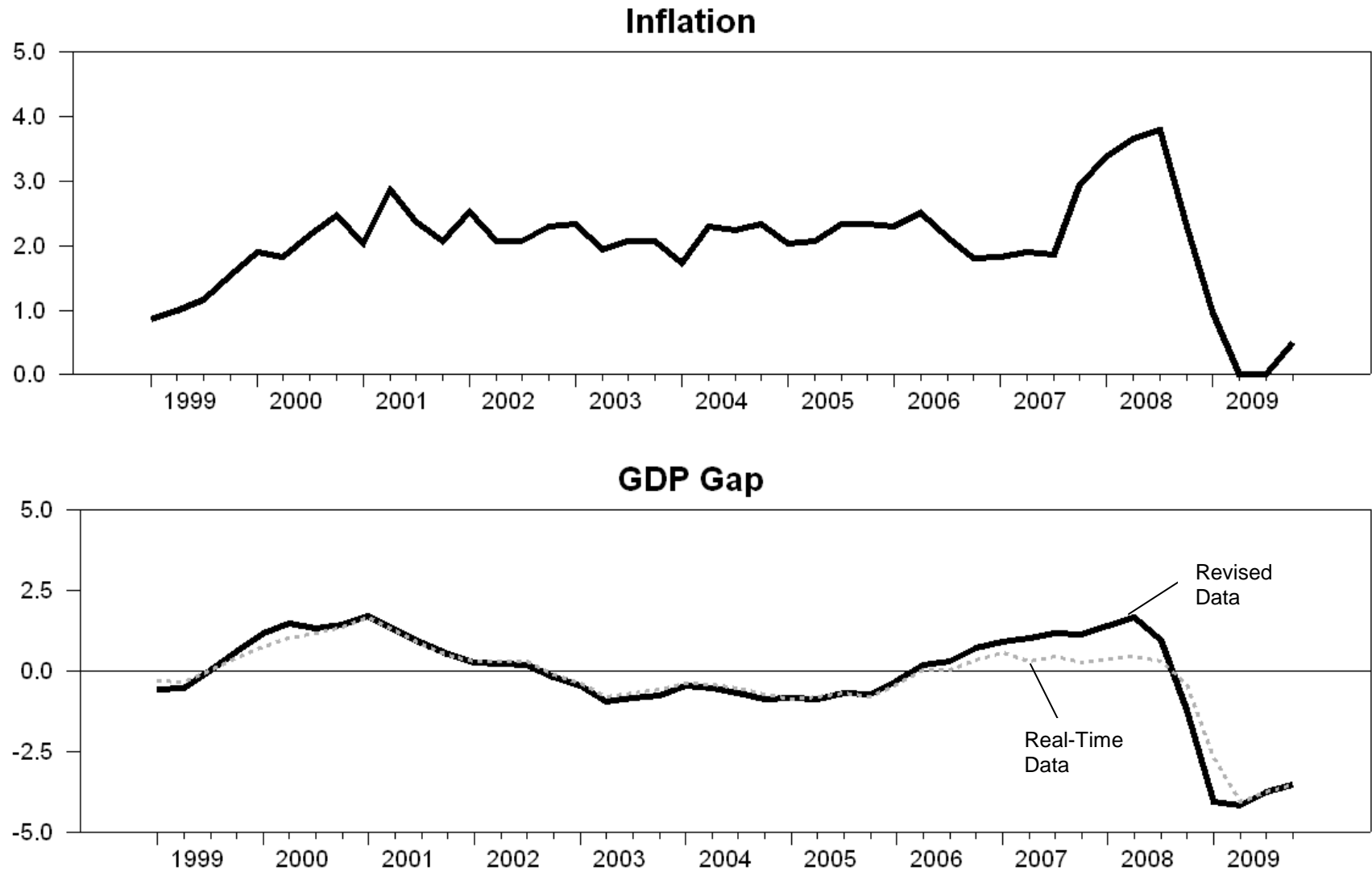
	Euro Area	Individual Country Model											
		Austria	Belgium	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain
$\alpha$	0.96* (7.51)	0.95* (8.03)	0.90* (5.68)	0.96* (7.68)	0.95* (8.92)	0.90* (7.89)	0.94* (5.73)	0.93* (8.86)	0.92* (8.62)	0.93* (4.40)	0.93* (6.02)	0.89* (5.95)	0.89* (7.20)
$\delta$	0.14*** (1.76)	0.10*** (1.72)	0.26** (2.10)	0.05** (2.59)	0.23** (2.72)	0.02*** (1.64)	0.47** (2.63)	0.07*** (1.64)	0.13 (0.67)	0.05** (2.33)	0.13* (2.58)	0.06* (2.44)	0.14* (3.39)
$\beta$	0.04*** (1.74)	0.01*** (1.71)	0.07*** (1.64)	0.10*** (1.68)	0.04*** (1.97)	0.11** (2.63)	0.21** (2.30)	0.14** (2.19)	0.12*** (1.64)	0.20*** (1.82)	0.02* (3.54)	0.04*** (1.58)	0.03 (1.19)
$\lambda_y$	0.12*** (1.86)	0.68* (2.65)	0.69* (3.70)	0.59* (3.20)	0.67** (2.60)	0.11*** (1.65)	0.04** (2.45)	1.21*** (1.81)	0.05*** (1.83)	0.23*** (1.88)	0.37** (1.99)	1.40** (2.03)	0.01** (1.93)
$\lambda_i$	0.002** (2.02)	0.001** (2.10)	0.06*** (1.75)	0.02*** (1.86)	0.002** (1.96)	0.004** (2.12)	0.09* (3.41)	0.50*** (1.76)	0.001*** (1.84)	0.003*** (1.77)	0.23** (2.04)	0.51** (2.11)	0.002*** (1.89)

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

**Table 2. Policy Response Coefficients.**

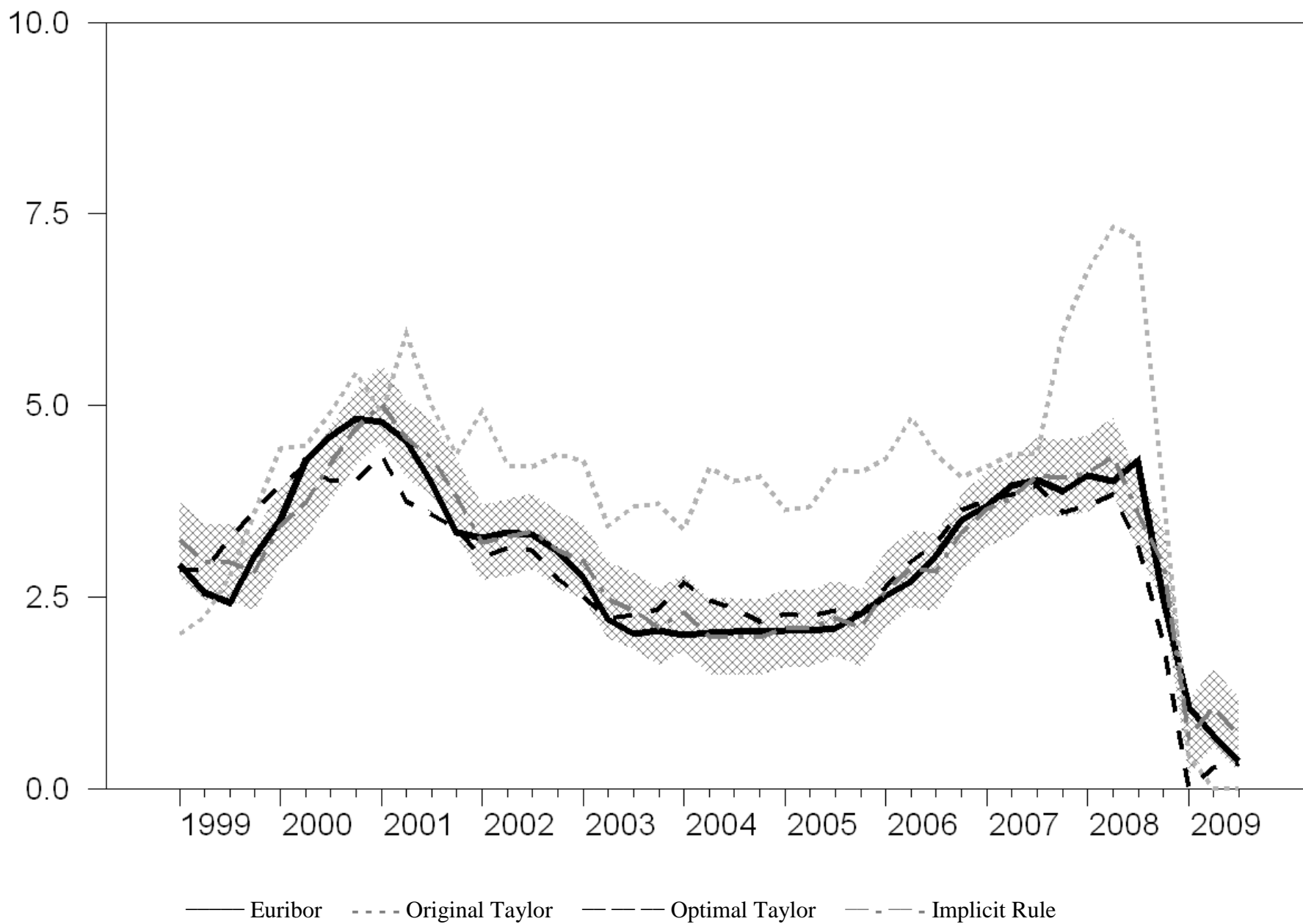
	<u>Original Taylor Rule</u>	<u>Optimal Taylor Rule</u>	<u>Implicit Policy Rule</u>
Coefficient on:			
Inflation gap ( $\pi_t - \pi^*$ )	1.5	1.06	1.06
Output gap ( $y_t$ )	0.5	0.73	0.53

**Figure 1. Euro Area Inflation and Output Gap Data.**

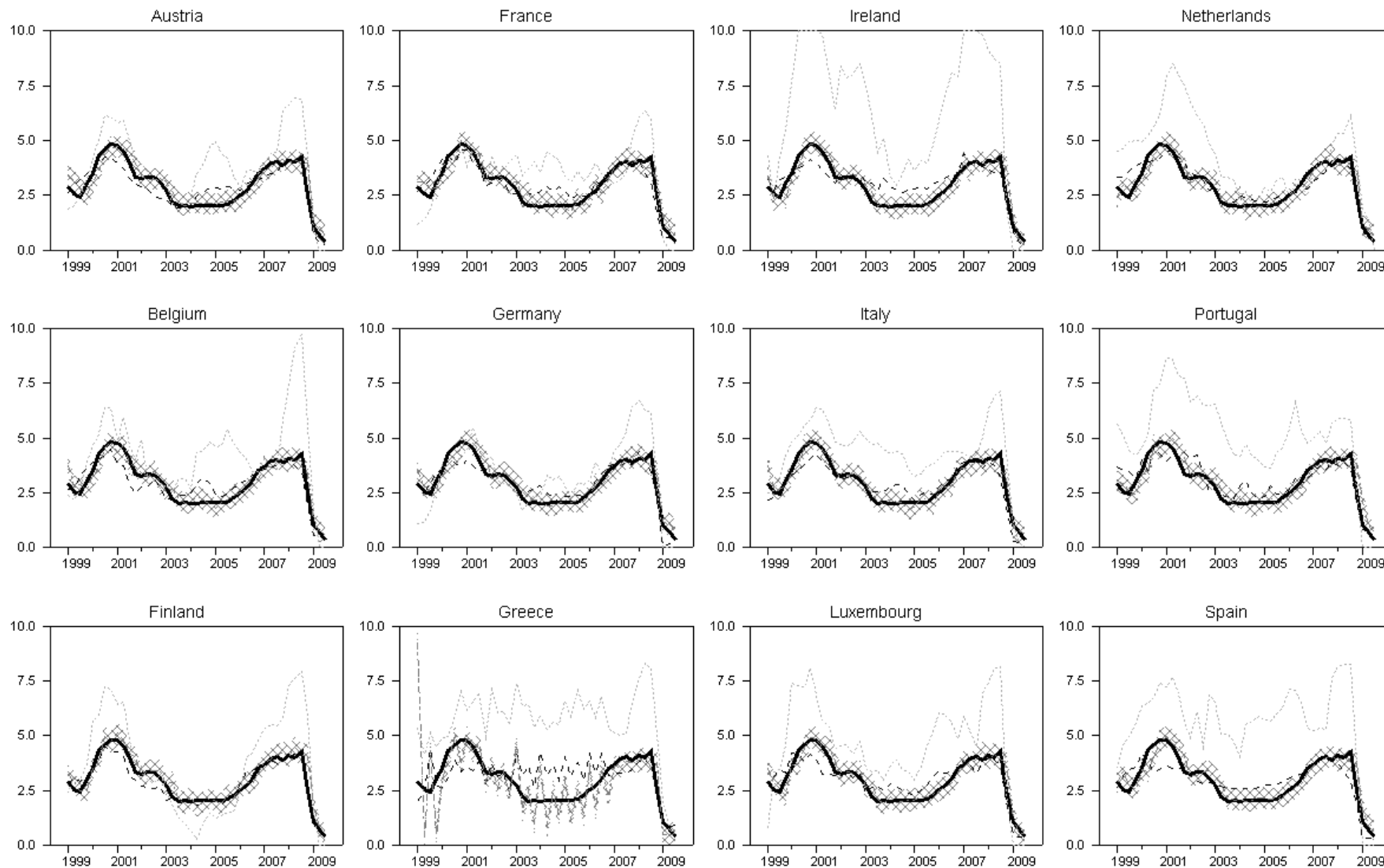




**Figure 2. ECB Policy Rates for the Euro Area.**



**Figure 3. ECB Policy Rates for Euro Area Members.**



— Euribor    ···· Original Taylor    - - - Optimal Taylor    - · - · Implicit Rule

Figure 4. ECB Policy Rates for the Euro Area (Real Time Data).

