

THE EUROPEAN CENTRAL BANK MONETARY POLICY  
AND THE TAYLOR RULE, 1999-2009

*LA POLÍTICA MONETARIA DEL BANCO CENTRAL EUROPEO  
Y LA REGLA DE TAYLOR, 1999-2009*

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ABSTRACT

In this paper, we try to see whether there is a model that can describe ECB monetary policy in simple, intuitive terms, and whether the model is consistent over time. We find such a model, which has the form of the Taylor rule. In fact, the main result of the paper points that ECB monetary policy in the last decade can indeed be described by a Taylor rule, with a caveat: the model fits the data soundly for two subperiods, 1999-2002 and 2007-2009, but does not work well for 2003-2006. Furthermore, the parameters that describe the Taylor rule are fairly stable over time, although the weight placed in output is slightly larger in 2007-2009 than in 1999-2002. Next, we compute optimal interest rates for some individual representative countries and, especially in the first of the subperiods for a set of countries that do not belong to the core of the Eurozone, find some significant divergences among their optimal interest rates and the rate set by the ECB.

*Keywords:* Monetary Policy; ECB; Taylor Rule; Optimal Interest Rates.

## RESUMEN

El principal objetivo de este artículo es averiguar si existe un modelo que describa la política monetaria del BCE de una forma simple e intuitiva, así como si ese modelo es constante en el tiempo. Un primer resultado relevante es que existe dicho modelo y que, de hecho, la política monetaria del BCE en la última década puede ser descrita por una regla de Taylor aunque con una salvedad: el modelo se ajusta convenientemente para dos subperiodos, 1999-2002 y 2007-2009, pero el ajuste no se alcanza para el subperiodo 2003-2006. Además, los parámetros que describen la regla de Taylor son bastante estables en el tiempo, aunque el peso relativo del output es mayor en el subperiodo 2007-2009 que en 1999-2002. A continuación, se calculan los tipos de interés óptimos para algunos países representativos y, especialmente en el primero de los subperiodos y para un conjunto de países que no pertenecen al núcleo de la Eurozona, se constata la existencia de algunas diferencias significativas entre sus tipos de interés óptimos y el tipo de interés establecido por el BCE.

*Palabras clave:* Política monetaria; BCE; Regla de Taylor; Tipos de interés óptimos.

*JEL Classification:* E43, E52, F33, F36.



## 1. INTRODUCTION<sup>1</sup>

Since 1999, the European Central Bank (ECB) has been in charge of the design and implementation of the monetary policy for those countries belonging in the Eurozone. The Treaty of Maastricht in 1992 and the Stability and Growth Pact in 1997 established a clear division of roles and competencies within the different authorities, national or supranational, of the countries that have the euro as the single currency. According to these agreements, the ECB is regarded as the sole authority for monetary policy, whereas fiscal policy remains designed and implemented at the individual country level, although with some restrictions, such as the need for the ratio public deficit/GDP to be less than 3%, and debt/GDP less than 60%. Finally, some guidelines are provided in the Lisbon Treaty of 2007 for structural reforms convenient for the UE members.

It could be said that this framework for economic policy in the Eurozone has worked in the last decades with mixed results. On the one hand, there is some consensus on the fact that ECB has had some success in the task of maintaining inflation low, although some authors suggest that there has been a period of perception of high inflation in the area, especially at the time in which the euro was introduced (De Grauwe, 2009).<sup>2</sup> It is possible, however, that divergences in competitiveness among euro members have increased (De Grauwe, 2006, 2009; Belke and Gros, 2007), although it is unclear whether the sole responsible for this should be the ECB. In any event, the ECB has been required to face constant and difficult challenges, such as the incorporation of new members in the Eurozone, abundant financial innovations and the own complexities associated to monetary policy. The task has been made even more burdensome because of the financial crisis that developed at the end of 2007 and the real crisis that it has brought about.<sup>3</sup>

<sup>1</sup> The authors would like to thank two anonymous referees for their helpful comments and suggestions. The usual disclaimer applies.

<sup>2</sup> More in particular, De Grauwe (2009) argues that sellers took advantage of the opportunity brought about by the introduction of the euro in order to increase concurrently the prices of the goods and services they deliver.

<sup>3</sup> For example, the fact that M3 seems no longer correlated with inflation as such but with asset bubbles (De Grauwe, 2009).

The concept of monetary policy endorsed by the ECB fits well within the framework of modern macroeconomics. There is now a widespread belief on the need of low inflation to promote real growth. In turn, and as inflation is regarded to be driven by expectations, it is crucial for central banks to anchor agents' expectations. For that to be possible, a central bank must be independent and have a clear, transparent and credible monetary strategy. In addition, this strategy must be well transmitted to markets and individuals. These features of modern monetary policy are prevalent even within the new Keynesian paradigm (Galí, 2008). In this regard, the main target of ECB over the past decade has been stabilizing the price level. In order to accomplish this goal, the institution has done a remarkable effort in terms of the appointment of directors, staff and technicians that work with *state of the art* models, the compilation and building of the statistical apparatus and the dissemination of publications and information on its role and task.

As pointed out above, the ECB has strived to reach and increase transparency over time and, despite its accomplishments in this regard, this task continues providing a challenge. One way in which transparency can be increased is by finding stylized, straightforward economic models that, despite their simplicity, are capable of characterizing and describing the links between monetary policy decisions and some fundamental variables that reflect the behaviour of the economy.

Furthermore, it has been 10 years since the ECB took over as the sole monetary authority for the Eurozone, and this seems an appropriate moment in order to look more carefully at the different aspects of its performance, and to inquire whether its decisions have been stable and consistent over time.

This paper fits in here. By means of extending the investigation described in Maza et al. (2008), we try to see, firstly, whether there is a model that can describe ECB monetary policy in simple, intuitive terms, and, secondly, whether the model is consistent over time. We find a model that fulfils these requirements. Our results suggest that the ECB monetary policy in the last decade can be described, to a certain extent, by a Taylor rule, although the fit is not equally sound in all subperiods.

The remainder of the paper proceeds as follows. In Section 2 we present a brief overview on recent monetary policy literature. In Section 3 we estimate a model of the determination of the interest rate by the ECB from January 1999 to December 2009; specifically, we estimate this model for the subperiods 1999-2002, 2003-2006 and 2007-2009. Finally, Section 4 concludes and produces future research directions.

## 2. LITERATURE ON THIS ISSUE

The Taylor rule originated in a paper published in the 90s (Taylor, 1993). Later on, it was recovered by other authors and popularised to such an extent that it may be regarded nowadays as a key component of the New Keynesian approach to monetary policy (Galí, 2008).

In his seminal paper, Taylor (1993) described the behaviour of the Fed rate over the years 1987-1992 as a function of prices and output. This idea can be expressed in algebraic form as the following equation

$$r_t = (R_t + i_t) + \beta(i_t - i^*) + \delta(y_t - y^*) \quad (1)$$

In which  $r_t$  stands for the nominal interest rate at period  $t$ ,  $R_t$  is the real interest rate in equilibrium,  $i_t$  is the actual rate of inflation in  $t$ ,  $y_t$  the actual growth rate of output in  $t$ ,  $i^*$  denotes the inflation rate specified as the goal and  $y^*$  is the desired growth rate of output. Taylor assumed that the coefficients  $\beta$  and  $\delta$  were 0.5.

Taylor's contribution fits well within the general development of Macroeconomics in the last decades of the 20<sup>th</sup> Century. The idea of monetary rules, although more or less explicit since the inception of economics, was brought to the forefront of the policy debate by Friedman. As it is well known, he proposed to monetary authorities a simple rule that entailed a constant rate of growth for money supply. This idea was heavily debated, but a new generation of macroeconomic models was gradually developing and permeating the economy. These models had usually detailed microfoundations, dealt with dynamic and stochastic considerations and treated expectations as rational. In this framework of analysis, optimal control techniques could be successfully employed to describe and characterize fine tuning macroeconomic policies, which were obtained as the outcome of standard intertemporal optimization problems.

This kind of more sophisticated models had some drawbacks, though. Generally speaking, they were quite complex and not robust to potential miss specifications or inadequate assumptions. It is not surprising, then, that some economists, and in particular Taylor, started to advocate a different policy strategy: one based, as Friedman defended, on simple rules.<sup>4</sup> Simple policy rules fitted also well in the framework of the new macroeconomic models, and were even more logically consistent with other pathbreaking contributions of the 70s, such as the Lucas critique. These policy rules were also appealing since they were not so crucially dependent on the underlying assumptions of the models, nor they imposed such demanding requirements of information on the behaviour of the economy as the non discretionary recommendations. There is some evidence suggesting that simple policy rules were adopted and employed in the 80s, 90s, and the first years of the 2000s (Taylor and Williams, 2009).

In the particular case of the Taylor rule, there are already a number of researchers, as Persson and Tabellini (1997), Clarida et al. (1998, 2000) and Orphanides (2002), that have tested empirically whether this model is

<sup>4</sup> For a thorough analysis on the similarities and differences of Friedman's and Taylor's approaches, see Nelson (2008).

capable of providing a sound description of monetary policy. These authors have estimated alternative versions of equation (1), main variations being the introduction of credibility of monetary institutions, expectations, unemployment replacing output growth and inertia in interest rates; this last variation is quite important as some papers (see, e.g., Sack and Wieland, 2000) reveal that the inclusion of an interest rate smoothing throw good results. Their general results point to the adequacy of the Taylor rule to describe the FED monetary policy making.

Other papers (Galí, 1998; Debrun, 2001; Aksoy et al., 2002; Angelini et al., 2002) have extended the analysis to other areas, as for example the Eurozone, both considered as a whole or decomposed in a number of countries. This approach has also become useful to go one step further and construct the hypothetical interest rate that would have prevailed in each of the euro countries under the scenario of autonomous monetary policy, thus computing the divergences between this rate and that fixed by the ECB (Lee and Crowley, 2009). In a sense, this indicator is a measure of the cost of the loss of the monetary sovereignty by countries that give up their currencies and join the euro.

In a previous paper (Maza et al., 2008), we applied this kind of analysis to data over the period January 1999-November 2005, and did find evidence of a Taylor rule characterizing the monetary policy of ECB, although with a relatively small weight given to output. As mentioned before, we want to extend this investigation here, assessing whether the results carry over when different subperiods are considered.

### 3. EMPIRICAL ANALYSIS

Before turning to the estimation of a Taylor rule for the ECB monetary policy, main goal of this section, it is worth pausing for a moment to describe the data and sample used to do it.

#### 3.1. DATA AND SAMPLE

In this paper we have performed an estimation of a slightly modified version of equation (1) above. Specifically, we regress the nominal interest rate of the Eurozone on a constant, the differential of the inflation with respect to a reference value and the differential of the output growth rate with respect to a reference value. As the left hand side of our equation, namely the interest rate fixed by policy makers, we have used the interest rate for main refinancing operations of the ECB. The regressors have been, apart from a constant, several variables that proxy the dynamics of inflation and output. In order to capture the first one, we have used the growth rate of the Harmonized Index of Consumer Prices; the goal inflation has been the specific target of ECB,

2%. Output growth, in turn, has been proxied by the evolution of the Industry Production Index (IPI); the desired rate of growth of output, based on the medium-term assumption established by the ECB, has been placed again in 2%.<sup>5</sup> It can be argued that the IPI is not devoid of some shortcoming, such as volatility and potential mismeasurement of particular sets of industries or goods. However, we think that it can be suitable for short run macro analysis, as the one carried out in this paper. Finally, as regards data collection, we have taken these data from the Statistical Office of the European Union, EUROSTAT. We have chosen this databank for two main reasons: first, because it is the source employed by ECB and, second, because it offers homogeneous data for all European countries.

Regarding the countries that could potentially encompass the sample, we have chosen the Eurozone of 15 members. It is true that some of these countries joined the euro in different moments of time, and did not belong in it from the beginning, but we have preferred to use a homogeneous sample through the period.<sup>6</sup> The time span analysed is 1999-2009, divided in monthly observations.<sup>7</sup>

Finally, it is also necessary to recall that we have worked with lagged values of the regressors in order to capture the delay associated with the process of decision making and implementation of the different measures by the ECB. Specifically, we chose (based on the Akaike Information indicator, among others) a lag of four months both on output and inflation. In any case, for the sake of robustness and following papers by García-Iglesias (2007) and García-Iglesias and Pateiro (2009), we have also combined a backward looking with a forward looking strategy: interest rate has been considered a function of past output and of future or expected inflation. More specifically, we have regressed interest rates on output lagged six months and on inflation with a lead of three months. As will be seen, the choice of the lag and/or lead does not affect much the results of the estimation.

### 3.2. ESTIMATION AND RESULTS

Since we were dealing with time series, first, we tested for the presence of unit roots in the data, by means of conventional tests, especially the Augmented Dickey-Fuller. We could not reject the hypothesis of the variables being integrated of order (1) at conventional levels. The next step was to

<sup>5</sup> The trend of real gross domestic product growth lies in the range 2-2.5% per annum (ECB, 1999).

<sup>6</sup> The Eurozone was initially composed by: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain. Greece joined the euro in January 2001, Slovenia in January 2007 and Cyprus and Malta in January 2008. We discarded Slovakia since it joined the euro in January 2009.

<sup>7</sup> An additional reason to justify the election of the IPI as our output proxy is that there are monthly data available for it in EUROSTAT, this not being the case for GDP (only quarterly). From the point of view of size sample, then, IPI turned out to be preferable to GDP.

determine whether the series were cointegrated to avoid spurious regressions problems; in order to do this we applied the Johansen tests, which suggested that the series were indeed cointegrated. Thus, we had to choose the most appropriate methodology for the estimation in this scenario. We decided to employ the Engle-Yoo (1991) three steps estimation procedure, suitable for models in which data are  $I(1)$  and cointegrated.<sup>8</sup> In addition, we employed the Newey-West procedure in order to correct for heteroskedasticity and autocorrelation and obtain consistent estimates.

As far as the time span was concerned, we estimated the model for the whole horizon 1999-2009, but obtained inconclusive results. A Chow test (results available under request) ratified that indeed the model could not be used throughout the entire sample. Alternatively, we decided to split the sample in various subperiods. This approach, while improving the econometric results, could be used also as a natural test of the consistency of the ECB policy rules over a period in which the economic situation changed dramatically. A Chow test revealed the existence of breakpoints in January 2003 and December 2006, so we divided the whole sample in three subperiods. When we pursued this strategy, we found, in the two alternative specifications detailed above, that the Taylor rule did a good job of describing monetary policy for two subperiods, 1999-2002 and 2007-2009.<sup>9</sup> However, the results did not agree with the existence of a Taylor rule underlying the data for the subperiod 2003-2006.

Let us look into these issues more in detail. Table 1 displays main results of the estimation both in the case of a lag of four months in the regressors (case a in the Table) and in the case of a lag of six months on output and a lead of three months on inflation (case b). The coefficients of differential inflation and differential output are, in both cases, positive and significant at conventional levels in the first (1999-2002) and third (2007-2009) subperiods. The basic message conveyed by the Table is that the monetary policy of ECB can indeed be described by a Taylor rule, by which interest rate adjusts to deviations of inflation and growth rate from baseline values of 2% per year. In both subperiods the weight placed on inflation is remarkably larger than that of output, which is coherent with the priority of the ECB, namely the control of inflation.

<sup>8</sup> A description of the estimation process is shown in Maza et al. (2008).

<sup>9</sup> A dummy from the last quarter of 2008 onwards, intending to capture the change in the economic situation alluded to above, was included in the final subperiod.

TABLE 1. TAYLOR RULE IN THE EUROZONE, 1999-2009 (ENGLÉ-YOO THREE-STEP ESTIMATOR)

<i>Dependent variable: ECB interest rate for main refinancing operations</i>			
<i>Case a: lags of four months (both inflation and output)</i>			
	Subperiods		
	1999:01-2002:12	2003:01-2006:12	2007:01-2009:12
Inflation	0.99 (4.71)*	-0.33 (0.09)	0.31 (6.41)*
Output	0.12 (3.00)*	-0.57 (1.43)	0.10 (9.09)*
Dummy 2008			-1.49 (21.28)*
Adjusted R <sup>2</sup>	0.84	0.39	0.95
Number of observations	48	48	36
Relative weights			
Inflation	89.19%		75.49%
Output	10.81%		24.51%
<i>Case b: lead of three months (inflation) and lag of six months (output)</i>			
	Subperiods		
	1999:01-2002:12	2003:01-2006:12	2007:01-2009:12
Inflation	0.73 (2.43)*	-1.23 (0.53)	0.29 (3.55)*
Output	0.16 (4.00)*	-1.06 (1.92)	0.14 (15.00)*
Dummy 2008			-0.98 (10.88)*
Adjusted R <sup>2</sup>	0.79	0.39	0.92
Number of observations	46	48	36
Relative weights			
Inflation	82.02		68.09%
Output	17.98%		31.91*

Notes: t statistics in brackets; \* significant at 99% level.

Source: EUROSTAT

Yet, results vary over time. Coefficients for deviation of inflation and deviation of output are, for the first subperiod, 0.99 (0.73 in the combination of a backward looking and a forward looking strategy) and 0.12 (0.16), and, for the third, 0.31 (0.32) and 0.10 (0.15). In other words, and in normalized values, the relative weight placed on inflation is 89.19% (82.02%) over the first subperiod 1999-2002, whereas the figure for output is 10.81% (17.98%). Over the third time span, inflation weights for 75.49% (68.09%) and output represents 24.51% (31.91%). This relative rise in the importance attached to output is also consistent with the recent episodes in the world economy, and in particular with the financial crisis developed at the end of 2007, that

ended up generating dismal expectations on the economy, fuelling uncertainty and eventually bringing about a recession or a deceleration of growth in most countries, with even fears of deflation in some cases.

Our results suggest, therefore, that the authorities that encompass the ECB were not impervious to these concerns, and that these worries translated into monetary policy decisions that paid more attention to output than those made in the past. It should be recalled that between September 2008 and May 2009 the ECB interest rate for main refinancing operations fell from 4.25% to 1%, more than 300 basic points.

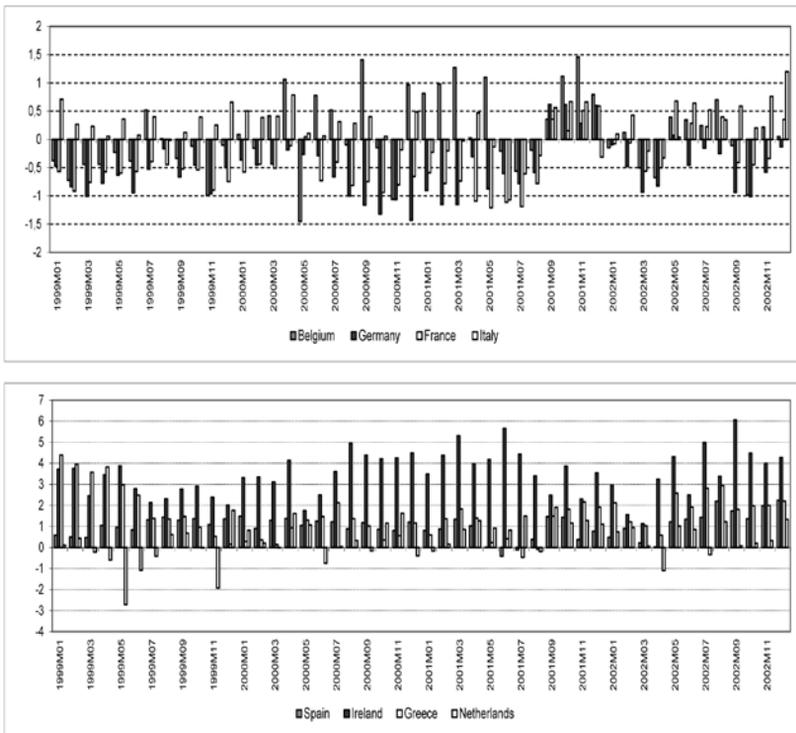
It is also convenient to note that the point estimate for inflation is less than one, especially so in the third subperiod, suggesting that the ECB monetary policy has been accommodative rather than stabilizing. At first sight this result may be surprising. Although it is left for future research to check the robustness of this result, it is somehow more understandable in the framework of the single monetary policy, in which the need to harmonise different requirements of the country members may reduce the case for aggressive measures. Furthermore, the complex characteristics of the third subperiod, 2007-2009, and the contradictory signals sent by different indicators (growing inflation coexisted with credit constraints and severe lack of liquidity in financial markets) could have induced the ECB to be less drastic in its design of monetary policy: recall that whereas the FED has placed its discount rate in the vicinity of zero, the ECB has not lowered its main interest rate below 1%.

As it was said above, in the second subperiod (2003-2006), instead, our results are not consistent with the existence of a Taylor rule. This time span remains a bit of a puzzle, and requires more investigation, since the criteria employed by the ECB in this subperiod to fix the interest rate are less clear to us and can not be traced out to the behaviour of inflation and output alone, at least on an *a priori* basis. This is in part understandable, because many things were going on at that time in the financial and real markets. Nonetheless, and as suggested by recent episodes such as the financial crisis erupted in 2007, this period turned out to have been critical: some studies point to the lax monetary policy of these years as one of the causes of the real estate asset bubble that burst dramatically in 2006-2007; this black box of monetary policy in 2003-2006, thus, deserves further and closer attention. This is an interesting aspect for future research.

The next step in our analysis was to compute hypothetical or optimal interest rates for some individual representative countries in those subperiods where a Taylor rule provided a good approximation of monetary policy. To do that, we relied on the assumption that the parameters for inflation and output would be the same as those used by the ECB, but substituting deviation in inflation and deviation in output by the values implied by each country's individual data. The smaller the difference (calculated as country optimal interest rates minus ECB interest rate) between the hypothetical and the ECB rate, the smaller the cost derived from the loss of monetary sovereignty. Results of this exercise are summarized in Figures 1-2. For brevity's sake, we only computed optimal interest rates when a lag of four months is included in the specification of the Taylor's rule equation.

The Figures convey some interesting messages. First, there are discrepancies between optimal interest rates for each country in particular, and the interest rate set up by ECB. These divergences are not uniform, however. They are relatively reduced for countries such as Germany,<sup>10</sup> France, Italy or Belgium, whereas they are especially significant for countries that do not belong in the traditional core of the Eurozone, as Ireland, Spain and Greece. It should be recalled that in Ireland and Spain, and also in Netherlands, real estate prices grew very fast in the years previous to the financial crisis. One may wonder if higher interest rates could have prevented, at least partially, the appearance and subsequent collapse of the real estate bubble in these nations. This line of reasoning, in addition, agrees with that of Flaig and Wollmershaeuser (2007), who argue that interest rates have been too low for most of the euro members over 1999-2005.

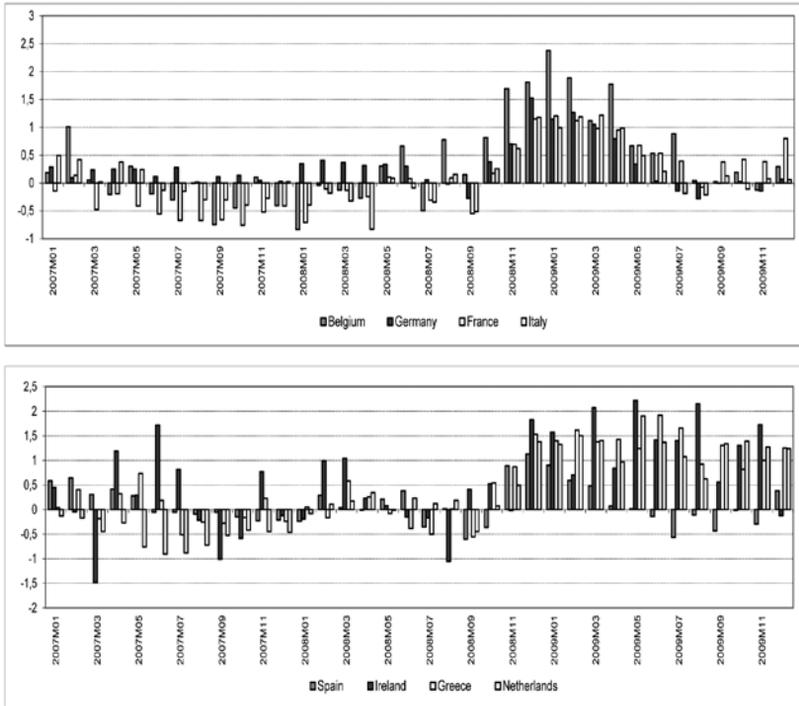
FIGURE 1. DEVIATIONS IN OPTIMAL INTEREST RATES, 1999-2002



Note: Deviations are computed as country optimal interest rates minus ECB interest rate  
 Source: EUROSTAT.

<sup>10</sup> This result should be expected because as Hieronymi (2009), among others, indicates, “the agreement was that the European Central Bank should be modeled on the German Bundesbank: ... a principal bastion of ‘virtuous (i.e. anti-inflationary)’ monetary nationalism”.

FIGURE 2. DEVIATIONS IN OPTIMAL INTEREST RATES, 2007-2009



Note: Deviations are computed as country optimal interest rates minus ECB interest rate.

Source: EUROSTAT.

Second, divergences are larger in the subperiod 1999-2002 than in the 2007-2009. This may point out to a true process of convergence within the Eurozone (Erber and Hagemann, 2009), or to a rather symmetrical response of countries to the crisis. Here, the case of Spain should be noticed: the magnitude of the real crisis has entailed the need for very low interest rates – even lower than that settled by the ECB – at some points of the last year of study (2009).

4. CONCLUDING REMARKS

Although the study of the ECB monetary policy has been carried out from different perspectives in the last few years, the uniqueness and relevance of this institution and also the precise historic moment we are into, full of challenges



and uncertainties, render it advisable to continue devoting time and effort to this issue.

This paper has intended to get some insights of the monetary policy designed and implemented in the Eurozone in the last decade. More in particular, it has tried to characterize this policy by means of a simple model, along the lines of the Taylor rule. We have reached some interesting findings:

1. First, our attempt to accommodate a Taylor rule to the ECB policy decisions has been quite successful. Our empirical work suggests that the monetary policy of ECB in 1999-2002 and 2007-2009 can be characterized by a Taylor rule; in other words, ECB monetary policy was influenced by the same points as are embedded in the Taylor rule, namely deviations of inflation from the ECB inflation objective, and deviations of output growth from its desired (based on ECB assumptions) growth rate. In our view, this result is relevant: in its 10 years of existence, the ECB has strived to acquire a remarkable level of transparency in its decision making procedures and in its communications with markets and the general public. In order to continue to augment this transparency, it can be helpful to gradually explain the monetary policy designed and implemented by this institution by simpler, more parsimonious models that try to capture only the relationships among the crucial variables. Monetary policy in 2003-2006, however, is more difficult to interpret and does not relate easily to inflation and output dynamics.

2. The results are fairly consistent among periods. The relative importance attached to price stability and the level of activity is quite stable over time, although the weight placed in output is slightly larger in the 2007-2009 subperiod. This outcome is not strange, given the financial and real crisis that has hit the world economy, including the Eurozone, in this subperiod.

3. We have also computed optimal interest rates for some individual representative countries, defined as those adapted to the Taylor rule in terms of the relative importance attached to prices and output, but that take into account the particular circumstances of each country regarding inflation and production growth rate. There are noticeable divergences among policy rates and optimal rates in the subperiod 1999-2002, especially for a set of countries that do not belong in the core of the Eurozone and that would have required, as our results reveal, higher rates. Divergences decrease, though, in the subperiod 2007-2009.

While appealing, our results should be considered as furnishing only a broad picture of a much more complex phenomenon which requires further investigation. In particular, a clear avenue for future research would be to evaluate the robustness of these results by taking alternative estimation strategies and variables, and look deeper in the interest rate divergences among countries. We also want to explore some variables that, to our knowledge, have not received a close attention when describing monetary policy, such as for example housing prices. Finally, another possible extension of this work is to focus on the monetary policy during the period 2003-2006, trying to figure

out the rationale underlying the decisions made by the ECB in this period. These and other questions will be tackled in future research.

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