Actual versus Perceived Taylor Rules. How Predictable is the European Central Bank?*

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Abstract

This paper investigates the predictability of the European monetary policy through the eyes of the professional forecasters from a large investment bank. The analysis is based on forward-looking Actual and Perceived Taylor Rules for the European Central Bank which are estimated in real-time using a newly constructed database for the period April 2000-November 2009. The former policy rule is based on the actual refi rate set by the Governing Council, while the latter is estimated for the bank's economists using their main point forecast for the upcoming refi rate decision as a dependent variable. The empirical evidence shows that the pattern of the refi rate is broadly well predicted by the professional forecasters even though the latter have foreseen more accurately the increases rather than the policy rate cuts. Second, the results point to an increasing responsiveness of the ECB to macroeconomic fundamentals along the forecast horizon. Third, the rolling window regressions suggest that the estimated coefficients have changed after the bankruptcy of Lehman Brothers in October 2008: the ECB has responded less strongly to macroeconomic fundamentals and the degree of policy inertia has decreased. A sensitivity analysis shows that the baseline results are robust to applying a recursive window methodology and some of the findings are qualitatively unaltered from using Consensus Economics forecasts in the regressions.

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1 Introduction

It has often been argued in the recent monetary economics literature that modern Central Banks follow a Taylor Rule essentially as a guiding principle for the implementation of their monetary policy strategy rather than as a strict rule of thumb. In a forward-looking environment, monetary policy is mainly considered as the art of managing the expectations of private agents, as has well emphasized Michael Woodford (2003). In the same spirit, the President of the Governing Council of the European Central Bank (ECB), Jean-Claude Trichet, has defined the monetary policy strategy during a press conference on 31 August 2006: *"Our concept is very simple: we do what -in our opinion- is necessary to counter the inflationary risks that we see, to deliver price stability over the medium term and to be credible in the delivery of price stability [...] I do not want to qualify in any other manner what we will do in the future, because, once again, we will do what we have to do in order to deliver price stability, be credible in the delivery of price stability over the medium term and continue anchoring inflationary expectations."*

The previous statement points out that the ECB's strategy is based on the firm commitment to deliver price stability in the policy relevant medium to long term horizons within a flexible monetary policy framework.[1] In this perspective, the European monetary policy can be characterized as a constrained discretion framework which features the absence of pre-commitment to future policy decisions. Thus, while being fully transparent about the inflation objective, the Governing Council remains silent on the future orientation of monetary policy. Hence, with regard to the latter its communication with the relevant economic agents breaks down. This limited procedural transparency of the Central Bank might hamper the predictability of the future monetary policy stance which would adversely affect the credibility of the ECB.[2] De Haan, Amtenbrink and Waller (2004) point out that the ECB does not seem to be perceived as transparent and credible based on a survey they have conducted among professional economists in the first years of the common monetary policy. However, the policy statement of Mr. Trichet emphasizes the importance of being credible in order to shape the expectations of economic agents in line with the price stability goal of the ECB. An anchoring of the private sector expectations with those of the Central Bank reduces the overall macroeconomic uncertainty and enhances the predictability of monetary policy in the medium and longer terms. The alignment of expectations improves monetary policy effectiveness and fosters a low inflation credibility in the ECB. This strategy can be implemented by a transparent Central Bank that features excellent communication skills. In such a transparency enhanced framework the ECB could achieve a better anchoring of inflation expectations, thus contributing to sustainable growth and employment creation in the medium to long terms. Monetary policy is hence more effective at stabilizing key macroeconomic aggregates.

Given that, on the one hand the ECB is fully committed to the delivery of price stability, while on the other it is never pre-committed to its future policy decisions, it is important to analyze the implications of the current monetary policy framework for the predictability of the European monetary policy stance. Most of the previous literature has studied this issue on the basis of the predictability of the money market interest rates derived from futures contracts, as for instance in Kuttner (2001) and in Ross (2002). The latter have found that future contracts provide broadly accurate predictions of the money market interest rates

[1] The Governing Council has defined price stability as a yearly rate of inflation below 2%. More precisely, members of the Council have declared that their inflation objective corresponds to an inflation rate that is below but close to 2%. The latter embodies inflationary expectations remaining in the range of 1.7-1.9% over the policy relevant horizon. The ECB has also clarified that the medium term horizon corresponds to a period of approximately 2 years.

[2] For an extensive treatment of the relation between Central Bank transparency, communication and credibility one can refer to Blinder (2000), Blinder et al. (2001 and 2008), Demertzis and Hallett (2007), Geraats (2007, 2008 and 2009) and Woodford (2005).

the Central Banks seek to influence. Swansson (2006) has found that an improvement of the Federal Reserve transparency has gradually lead to more accurate private sector forecasts of the fed funds since the 1990's. Rosa and Verga (2007) argue that the forecast accuracy of the forthcoming refi rate based on the ECB communication is similar to the market based expectations for the main policy rate. Gerlach (2007) points out that the changes in the ECB's refi rate can be explained by subjective measures of the economic outlook based on the monthly bulletin of the Central Bank along with the growth rate of M3 and the nominal effective exchange rate. Conversely, the inflation rate and the output gap do not seem to play a role in the ECB's interest rate setting. More recently, using a new approach Hamilton, Pruitt and Borger (2009) have specified a market-perceived monetary policy rule to measure how market participants understand the Federal Reserve policy rule using macroeconomic news at a monthly frequency. Their model relates the change in the forecast of the future fed funds to a change in the forecasts of macroeconomic variables through a perceived Taylor Rule. Within this framework, the authors find that the market participants indeed extract information from macroeconomic news in order to predict the future fed funds. Their findings also point out that the estimated policy rule has changed over time. Sauer and Sturm (2003) have estimated Taylor Rules for the ECB and have found that the Central Bank implements an inflation destabilizing policy for inflation when using a backward-looking specification, however, its policy is inflation stabilizing when including forward-looking variables in the policy rule. Along the same lines, Gorter, Jacobs and de Haan (2008) show that the ECB responds to the expectations of inflation and real GDP growth using Consensus Economics Forecasts in real-time. The authors also point out that the estimates from a contemporaneous Taylor rule do not imply an inflation stabilizing policy of the Central Bank because of the lack of a forward-looking nature in the variables. Therefore, one should prefer a specification with expectations data in order to more properly model the preemptive behavior of Central Banks.

Consistently with this new line of research, this chapter contributes to the literature to the extent that it adopts an alternative approach to the analysis of monetary policy predictability. In contrast with the previous methodologies, I introduce a direct measure of the ECB's key policy rate point forecasts performed by the professional forecasters of a large investment bank. Thus, I examine whether the relevant market participants have accurately predicted the main policy rate of the Central Bank before each meeting of the Governing Council. An alignment between the private forecasts of the policy rate with the actual interest rate would point out that the Central Bank has used a similar information set on macroeconomic fundamentals when setting the refi rate as the professional forecasters. In that perspective, Berger, Ehrmann and Fratzscher (2009) analyze the forecast accuracy of the ECB's main interest rate using the Reuters' poll of economic forecasters over the period September 2000-January 2005. Within a panel approach, the researchers show evidence in favor of an important degree of forecast heterogeneity which they explain by geographic factors, information clustering in important financial areas and country specific macroeconomic variables. Finally, Boeckx (2011) uses monthly interpolated data from the quarterly ECB's Survey of Professional Forecasters (SPF) to estimate a policy reaction function for the ECB using inflation and real output growth forecasts within a discrete choice approach. He finds that the predictions from an ordered probit model are in general in line with the observed policy rate and that the Central Bank has responded less strongly to the economic forecasts since the height of the financial crisis in October 2008. However, a comparison of the results obtained from the probit model with the survey information from the Reuters' poll of forecasters points to some misalignments in the predictions. In contrast with the previous approaches, I assume that close to the monetary policy meetings, the market participants and the Central Bank should have broadly similar views on inflation and on the economic outlook, which are fostered by the economic transparency

of the ECB and its desire to align the private sector expectations with its macroeconomic forecasts.

In order to investigate the predictability of the key policy rate, I estimate a forward-looking specification of the Taylor Rule for the ECB, as well as a perceived Taylor Rule for the investment bank professional forecasters. As a dependent variable for the Actual Taylor Rule, I use the ECB's refi rate set on the corresponding monetary policy meeting, while the Perceived Taylor Rule is based on the professional point forecasts of the refi rate for the upcoming meeting. Any difference in the estimated coefficients or in the implied predictions of the policy rules might point to a limited predictability of the monetary policy stance. Such a finding could hinder the anchoring of private agents' expectations with the Central Bank's objective and would impair the effectiveness of monetary policy. Modeling private agents' perceptions of the future policy stance is particularly valuable for the appropriate design of monetary policy, as pointed out by van der Cruijsen and Eijffinger (2008) in a survey they have conducted on the perceived transparency of the ECB among the Dutch households. The researchers emphasize that the perceived transparency is more important than the actual one as the former permits to ensure a public support for the Central Bank. The authors show that the transparency perceptions can be further enhanced by improving the public knowledge about the Central Bank and increasing its degree of procedural and operational transparency. However, the ECB has an incentive to highlight its transparency strengths and not to disclose its weaknesses in order to foster pubic trust in the monetary institution.

The empirical results first suggest that the ECB's monetary policy is broadly well predicted by the professional forecasters within the estimated linear policy rules. However, the economists have foreseen more accurately the policy rate hikes than the interest rate cuts. There is also evidence for increasing Central Bank's reaction to inflation and output growth expectations along the forecast horizon. The evidence from the rolling and recursive window regressions indicates that there are some gaps between the actual and perceived point estimates over time, in particular since the height of the financial crisis in 2008. Finally, the results point out that the ECB has responded less strongly to key macroeconomic fundamentals and has adjusted faster the refi rate to the desired target level after the bankruptcy of Lehman Brothers. The time dummies show that the broadening of the financial crisis has exerted an important negative and significant effect on the estimated policy rules. Thereby, the evidence reveals that the ECB might have switched to a new monetary policy regime that occurs in periods of deep financial and economic slump.

The structure of the paper is the following. Section 2 presents the theoretical framework, while the data and methodology used are outlined in section 3. Section 4 contains the linear model estimations of the Actual and Perceived Taylor Rules, while the rolling window regressions are performed in section 5. Section 6 presents the estimation results of the policy rules with some relevant time dummies and section 7 conducts a sensitivity analysis of the baseline results. The final section provides some concluding remarks on the main empirical findings of the paper.

2 Theoretical framework

Following most of the recent literature, I specify a linear forward-looking policy reaction function.[3] This approach can be justified by the long and variable lags that are necessary

[3]The theoretical specification is based on Gorter, Jacobs and de Haan (2008), Clarida, Galí and Gertler (1998, 1999 and 2000) and Woodford (2001). This policy rule differs from the original Taylor Rule (1993) in that the former is forward-looking and the Central Bank responds to the growth rate of real GDP and not to the output gap.

for monetary policy to affect real economic activity. As in this perspective monetary policy becomes the art of managing the expectations of economic agents, the Central Bank is concerned about the predictability and credibility of its strategy. I assume that at the forthcoming monetary policy meeting, occurring in period $t+1$, the Central Bank sets the main interest rate based on the following Taylor Rule specification:

$$\bar{i}_{t+1} = r^* + \pi^* + \beta_\pi E_t \{\pi_{t+k} - \pi^* | \Omega_t\} + \beta_y E_t \{y_{t+k} - y^* | \Omega_t\} + \eta_{t+1} \quad (1)$$

where $\bar{i}_{t+1}$ denotes the Central Bank's target for the policy interest rate in period $t+1$, r^* and π^* are the equilibrium real interest rate and the inflation objective respectively. $E_t \{\pi_{t+k} - \pi^* | \Omega_t\}$ and $E_t \{y_{t+k} - y^* | \Omega_t\}$ are the inflation and real output growth expectations respectively made in period t for a horizon $t+k$, in deviation from the inflation objective π^* and the trend real output growth rate y^*. Ω_t denotes the available information set in period t and η_{t+1} is a stochastic disturbance term.[4] Notice that this specification of the Taylor Rule is in line with the speed limit policy recommended by Walsh (2003). The latter has shown that a Central Bank that responds to the change in the output gap rather than to its level can deliver the optimal pre-commitment policy outcome. This policy is also welfare improving compared to inflation targeting if the inflation process is forward-looking. I also introduce interest rate smoothing in the specification to account for the fact that usually Central Banks adjust gradually their policy rate to the desired level in order to avoid excess volatility in financial markets. The partial adjustment equation that accounts for this practice is the following:

$$i_{t+1} = \rho i_t + (1-\rho)\bar{i}_{t+1} + \xi_{t+1} \quad (2)$$

where i_{t+1} is the observed interest rate in period $t+1$, ρ is the interest rate smoothing parameter and ξ_{t+1} is a stochastic disturbance. This equation points out that the Central Bank implements a fraction $(1-\rho)$ of the desired policy rate target at each meeting of the policy committee. Combining equations (1) and (2) yields the final specification to be estimated:

$$i_{t+1} = \rho i_t + (1-\rho)[\alpha + \beta_\pi E_t \{\pi_{t+k} | \Omega_t\} + \beta_y E_t \{y_{t+k} | \Omega_t\}] + \epsilon_{t+1} \quad (3)$$

where $\alpha = r^* + \pi^*(1-\beta_\pi) - y^*\beta_y$.

Based on equation (3) I estimate an Actual Taylor Rule for which the dependent variable is the observed refi rate as set at the policy meeting in period $t+1$:

$$i_{t+1} = \rho i_t + (1-\rho)[\alpha + \beta_\pi E_t \{\pi_{t+k} | \Omega_t\} + \beta_y E_t \{y_{t+k} | \Omega_t\}] + \epsilon_{1t+1} \quad (4)$$

I also estimate a Perceived Taylor Rule which is based on the professional point forecast of the ECB's refi rate to be set at the forthcoming meeting of the policy committee performed by the economists of the investment bank one week ahead:

$$E_t \{i_{t+1}\} = \rho i_t + (1-\rho)[\alpha + \beta_\pi E_t \{\pi_{t+k} | \Omega_t\} + \beta_y E_t \{y_{t+k} | \Omega_t\}] + \epsilon_{2t} \quad (5)$$

In the specification of the Taylor Rules, I have assumed that both the Central Bank and the market participants share the same information set about macroeconomic fundamentals one week ahead of the Governing Council meetings. This is a reasonable assumption given that the ECB Council often refers to the inflation and real GDP growth forecasts of market participants when explaining monetary policy decisions during the press conferences. On a regular basis, the Council compares the ECB's staff macroeconomic projections with the

[4] In the empirical part of the paper, I use different forecast horizons in the estimation of the policy rules to determine to what extent the responsiveness of the Central Bank to macroeconomic fundamentals is sensitive to the measures of expectations and how it changes along the forecast horizon.

forecasts performed by the OECD, the IMF, the European Commission and Consensus Economics. In addition, the Central Bank conducts its own survey of inflation and real output growth expectations among a wide range of professional forecasters in the euro zone at a quarterly frequency (the ECB SPF). Using all macroeconomic projections from different agencies and surveys the ECB often highlights the fact that the forecasts are broadly well aligned. This evidence brings further support to the decisions taken on the main refinancing operations rate (the refi rate) of the ECB and should enhance their predictability. The current practice of the ECB points to a high level of economic transparency of the Central Bank even though the economic forecasts should be performed at the frequency of the Governing Council meetings. This practice would foster the predictability of the ECB's interest rate decisions by the relevant market participants. Another possibility would be to reduce the frequency of the monetary policy decisions and turn to quarterly policy meetings for instance.

3 Data and methodology

The aim of this paper is to assess the predictability of the ECB's main policy rate (the refi rate) by the professional forecasters of a large investment bank before each meeting of the Governing Council. This analysis is important as it will bring new light on determining whether the policy strategy of the Central Bank is well understood by the relevant economic agents and to what extent the monetary policy stance is accurately predicted in a real-time setting. While this issue is crucial for the communication strategy and transparency of the ECB with the markets, collecting data that are available to the market participants in real-time and at the frequency of the meetings of the monetary policy committee is a particularly difficult and challenging task. After a long and comprehensive exploration of numerous relevant data, I have collected the macroeconomic projections of a large investment bank that are available on a weekly frequency and in real-time. Based on these data, I have constructed a database that contains the real-time point forecasts of the refi rate for the upcoming policy meeting, inflation and real GDP growth for the euro area as reported by the economists of the bank in their weekly economic research publications.[5] The macroeconomic forecasts are performed for the current quarter and the quarter ahead, as well as for the current year and the year ahead. This framework is particularly well suited for assessing the predictability of the European monetary policy stance based on the Actual and Perceived Taylor Rules derived in the previous section.

Since there are no forecasts of the output gap performed at the frequency of the Governing Council meetings I use the projections of real GDP growth in the regressions[6]. The approach I adopt is consistent with the methodology used by Gorter, Jacobs and de Haan (2008), Sturm and Wollmershäuser (2008) for instance who assume a constant growth rate of potential output.[7] Orphanides and van Norden (2002) have highlighted the important revisions in the output gap estimates which render the use of real-time output gap forecasts unreliable. According to the authors the main problem lies in the end-of-period estimates of potential output which are not completely trustworthy with the methods applied to

[5] I have built-up the database from their weekly economic reports made in general one week before the upcoming monetary policy meeting of the ECB. The forecasts are provided in real-time and thus are not subject to the Orphanides' critique (2001). The latter has shown that one should use real-time data for actual policy making because revised data could yield misleading outcomes. Further evidence on the use of real-time rather than revised data is provided in Molodtsova, Nikolsko-Rzhevskyy and Papell (2008).

[6] This method is based on the speed limit policy described by Walsh (2003). The latter has emphasized that a policy rule in which the Central Bank responds to the change in the output gap is welfare improving especially in the case of imperfect observation of the output gap.

[7] Within this more general approach it is reasonable to assume that the euro area potential output has most likely not changed within the relatively short time period investigated.

extract potential output, and hence could lead to mistaken policy recommendations. This is unlikely to be the case for the real GDP growth forecasts used in this paper which are not revised.

As pointed out previously, the investment bank's economists report the most likely point forecast for the refi rate set by the ECB Governing Council at the upcoming monetary policy meeting. The forecasts are usually made in the week before the corresponding policy decision and are based on the economists' projections of key macroeconomic variables for the euro area. The database spans the period from April 2000 until November 2009. The frequency of the observations corresponds to the meetings of the Governing Council of the ECB which are in general monthly.[8] A detailed description of the variables used is provided in table A.1 in the appendix. Table A.2 reports some summary statistics of the series used in the estimations. At a first look at the table one can see that the average of the inflation expectations of the economists for the year ahead is 1.807% which is fully in line with the inflation objective of the ECB. This result is corroborated by the consensus average inflation forecast which is 1.814% for the year ahead. This evidence suggests that the Central Bank has been successful at anchoring the inflation expectations of the market participants. Data on the key policy interest rate are taken from the official website of the ECB. Figure 1 displays the timing of the model.

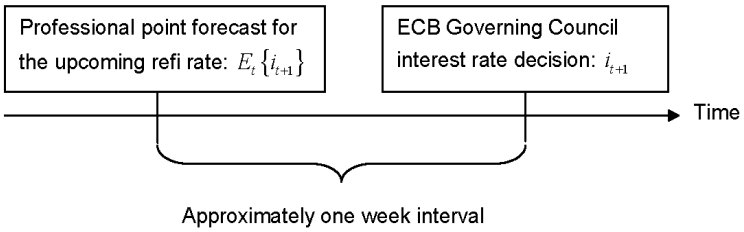

Figure 1: The timing of the model

The approach adopted in the chapter is also consistent with Sturm and Wollmershäuser (2008) who have estimated monetary policy rules for the euro area using expectations data at the frequency of the Governing Council meetings. The goal of their paper is to determine the adequacy of the ECB's monetary policy for the euro area countries. They have found evidence that there are important stress levels in the disaggregated analysis between the monetary union member countries and that the ECB has actually put a higher political weight on the smaller states when deciding on the appropriate level of the refi rate. The methodology is also in line with the approach adopted in Berger, Ehrmann and Fratzscher (2009) and Boeckx (2011) who have analyzed the forecast accuracy of the ECB's refi rate. In addition, Coibion and Gorodnichenko (2011) have recently shown that the Federal Reserve has responded to the inflation and output growth forecasts from the Greenbook data set they have used in estimating the monetary policy rules at the frequency of the FOMC meetings.

Figure 2 compares the actual refi rate set by the ECB with the refi rate point forecast from the economists of the investment bank before the corresponding monetary policy meeting. This analysis provides a first evidence for understanding the forecasting of the main policy rate of the ECB. The figure points to a possibly hampered predictability of the

[8]The Governing Council has taken monetary policy decisions twice a month until October 2001. In the empirical part of the paper I present the estimation results of the policy rules that contain a dummy variable for the period when the Council has met more than once within a month. It is also important to emphasize that the frequency of the monetary policy meetings reflects the time period that is required to assess the monetary policy stance and is not necessarily associated with a change in the underlying monetary policy rule. Moreover, Berger, Ehrmann and Fratzscher (2009) do not find evidence that the number of meetings of the Governing Council has altered the forecast accuracy of the refi rate.

refi rate in the period from 2000 to the end of 2003 as indicated by the recurrent prediction errors. During the cycle of policy easing the forecasters have often expected higher refi rate cuts than the ones implemented by the Central Bank. Even though the economists have not predicted well the magnitude of the policy rate adjustments, they have managed to perceive broadly well the pattern of the policy rate in that period. Since June 2003 and until December 2005 the economists' point forecasts of the refi rate have remained at 2% in line with the actual policy rate. There has been only one exception in March 2004, when the economists have perceived a further decline of the refi rate to a level of 1.75% which the ECB has not implemented. The gradual monetary policy tightening that the Central Bank has started in December 2005 has been remarkably well predicted by the market participants one meeting ahead. Finally, the professional forecasters have fallen short into perceiving the timing and magnitude of the refi rate cuts during the recent financial crisis, even though they have broadly well predicted the monetary policy easing that has been implemented since October 2008.

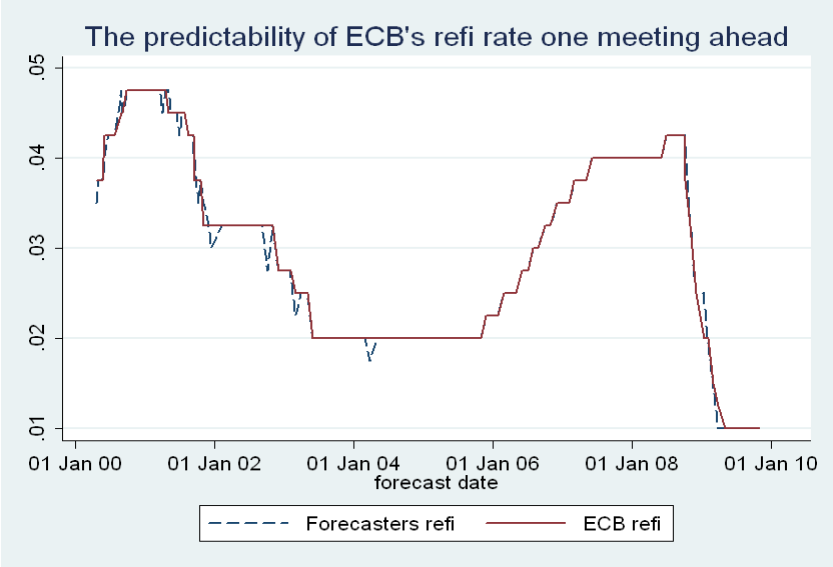

Figure 2: The predictability of ECB's main policy rate by the professional forecasters

Table 1: The refi rate adjustments

The magnitude of the changes in the refi rate							
	-75 b.p.	-50 b.p.	-25 b.p.	0 b.p.	+25 b.p.	+50 b.p.	+75 b.p.
Number of changes implemented	1	8	5	108	12	1	0
Number of changes predicted	1	7	9	106	11	1	0
Correct predictions	100%	50%	40%	94.4%	83.3%	0%	n.a.

Note: The table displays the changes of the refi rate expressed in basis points that the ECB has implemented along with the predictions performed by the investment bank's economists. The latter are used to determine the point forecasts of the policy rate. n.a. refers to a rate change that is not observed during the period studied.

Table 1 reports the number of the refi rate adjustments the ECB has implemented along with the changes in the policy rate predicted by the professional forecasters from April 2000 to November 2009.[9] The results indicate that during most of the meetings the Governing Council has not changed the refi rate, while there have been almost as many rate

[9]Notice that as an alternative approach one could model the probability of having a particular change in the refi rate. However, this analysis has been performed to some extent in the recent literature. Instead, in this paper I model the market participants' perception of the Central Bank's reaction function within a Taylor Rules framework.

cuts as interest rate hikes. The reported correct predictions take due account of the timing of the interest rate decisions. They point out that while the investment bank's economists have broadly well predicted the increases in the refi rate and the unchanged policy rate, the professional forecasters have experienced a hard time in forecasting the refi rate cuts of the Central Bank. This evidence mirrors the communication policy of the ECB. Indeed, given that the Governing Council has been perfectly clear on its firm commitment to foster price stability as its overriding goal, the market participants have remarkably well foreseen the timing and the size of the refi rate hikes the ECB has implemented to alleviate some inflationary pressures. However, as the Council has not explicitly clarified the weight it assigns to the economic outlook when deciding on the level of the refi rate, the investment bank's economists have not well predicted neither the timing nor the magnitude of the refi rate cuts the Central Bank has implemented in response to a fall in economic activity or to a financial slump. The results thus unveil the asymmetry inherent to the ECB's communication policy: the Central Bank signals in advance the forthcoming rate hikes while it often remains silent on the future rate cuts. Using a wording indicator, Ullrich (2008) shows that the inflation expectations of financial markets experts are influenced by the ECB's communication at press conferences. Besides, Ehrmann and Fratzscher (2009) point out that the communication of the Central Bank during the press conferences exerts a clarification role of the monetary policy decisions especially in periods of heightened macroeconomic uncertainty. On the one hand, the good predictability of the refi rate increases since December 2005 might be partly related to the use of some code words like "vigilance" and "strong vigilance" in the ECB's communication with the markets, as is emphasized in de Haan and Jansen (2009). On the other hand, Geraats, Giavazzi and Wyplosz (2008) highlight that the system of code words has not been very successful because the market participants have not accurately foreseen the overall stance of policy tightening further in advance and the system has been used only to signal the policy rate hikes. This practice possibly explains the smaller forecast accuracy of the refi rate cuts one week ahead of the Governing Council meetings. As in general the "traffic light system" of the ECB seems to be quite confusing to the market participants for perceiving the overall policy rate strategy, one should rely on a Taylor Rule framework to better understand and predict the refi rate setting policy of the Central Bank.

Along with the point forecast for the policy rate, the economists report their prediction of inflation and real GDP growth for the current quarter and current year, and for the quarter and year ahead. Based on the methodology of Gorter, Jacobs and de Haan (2008) I use two approaches in constructing the expectations of inflation and real output growth that are used in the empirical analysis.

In a first step to modeling the expectations of inflation and real output growth, I use for each period t the inflation and real output growth forecasts for the quarter ahead or for the year ahead respectively. The advantage of this methodology is that it is entirely forward-looking since I consider the economists' expectations for the upcoming quarter or for the upcoming year. This approach is also in line with the method applied by Poplawski-Ribeiro and Rülke (2010) in their investigation of the impact of the Stability and Growth Pact on the forecast accuracy of the public budget deficit in the euro area by the market participants. This methodology could also be consistent with the observed long and variable lags in the monetary policy transmission process.

The second methodology considers a fixed horizon of one-quarter which is computed for the inflation and real output growth forecasts using the following formula for the weighted average ($\bar{x}_{q,h}$):

$$\bar{x}_{q,h} = \frac{91-h}{90} x_{q,h} + \frac{h-1}{90} x_{q+1,h}$$

where $x_{q,h}$ is any of the current quarter (q) forecasts of the aforementioned variables re-

ported on day h and $x_{q+1,h}$ stands for the quarter ahead $(q+1)$ projections made in the same day. The indices q and h take respectively the values $q = 2000Q2, \ldots, 2009Q4$ and $h = 1, \ldots, 90$. I have considered 90 days within a quarter which is a standard assumption for financial markets' participants.

To obtain a one-year fixed horizon forecasts of the variables, I compute a weighted average $(\bar{x}_{y,h})$ of the current year and the year ahead forecasts using the following formula:

$$\bar{x}_{y,h} = \frac{361-h}{360} x_{y,h} + \frac{h-1}{360} x_{y+1,h}$$

where $x_{y,h}$ is any of the current year (y) forecasts of the macroeconomic variables reported on day h and $x_{y+1,h}$ stands for the year ahead $(y+1)$ projections published on the same day. The indices y and h take respectively the values $y = 2000, \ldots, 2009$ and $h = 1, \ldots, 360$ assuming 360 days within a year.

The advantage of this approach is that one obtains a fixed horizon of one-quarter and of one-year respectively for the inflation and real GDP growth forecasts. However, there are also some drawbacks related to this methodology. First, the variables computed are not entirely forward-looking since they contain expectations of the series for the current quarter and the current year. Second, by applying this formula we cannot assign a specific forecasting period to the expectations variables because they span any time interval that is between the current quarter and the quarter ahead or between the current year and the year ahead. Moreover, given that these variables are constructed from the reported forecasts they may not correspond well to the way the economists form their expectations of macroeconomic fundamentals. Conversely, the quarter and the year ahead projections published by the economists are purely forward-looking and hence are more likely to correspond with the expectations formation mechanism of the market participants compared to the forecasts of macroeconomic fundamentals obtained with the second approach.

Tables A.3 and A.4 in the appendix display the unit root tests of the variables that are used in the estimation of the Taylor Rules.[10] The results point out that most of the series seem to be stationary in light of the evidence from the Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. However, some of the Phillips-Perron (PP) tests do not show evidence against the null hypothesis of unit root, in particular for the actual and forecasted refi rates and for the real GDP growth forecasts. The latter results are at odds with the theoretical assumption of stationarity of the output growth rate and with the estimation results in the literature. In the empirical section I also report the unit root tests of the residuals along with the estimated coefficients. I have performed the Augmented Dickey-Fuller and the Phillips-Perron tests which point out that the residuals are all stationary. This brings evidence against any spurious regression problem that may arise along the lines of Granger and Newbold (1974). It should be emphasized that in the literature the researchers make the assumption of stationarity of the series when estimating Taylor Rules, even though it is often hard to reject the presence of a unit root in the macroeconomic time series used in the estimations. The latter assumption is justified by the generally low power of the unit root tests in small samples as outlined in Gorter, Jacobs and de Haan (2008), Clarida, Galí and Gertler (2000) for instance. Thus, the absence of evidence against the unit root hypothesis found with the Phillips-Perron statistics for some of the series in this paper is possibly due to the low power of the tests and the relatively short time period considered in the analysis. Therefore, given the strong theoretical arguments in favor of stationarity of the variables in the Taylor Rules the series can be considered as stationary.

In line with the literature, I adopt a GMM approach to estimate the policy rules. As instruments for the lagged policy rate I use the first and second lags of the inflation

[10] A comprehensive overview of the testing procedures is available in Maddala and Kim (2004).

and real output growth forecasts in the regressions.[11] To correct the standard errors of the estimates for heteroskedasticity and autocorrelation of unknown form, I follow the approach of Newey-West (1994) and apply a Bartlett kernel for the estimation of the variance-covariance matrix. This procedure yields consistent and unbiased coefficient estimates of the explanatory variables in the Taylor Rule. The inflation and output growth forecasts are exogenous regressors for several reasons. First, these forecasts are used in real-time by the investment bank's economists to perform their refi rate point forecast approximately one week ahead of the Governing Council meetings and hence are observed before the realization of the refi rate. Second, I have performed some endogeneity tests of the inflation and output growth forecasts and the difference-in-Sargan statistics all point out that there is no evidence against the null hypothesis of exogeneity in all regressions. Third, the evidence documented in the literature, as in Gorter, Jacobs and de Haan (2008) and Sturm and Wollmershäuser (2008) for instance, supports the view that in the Taylor Rule framework the projections of macroeconomic variables provided in real-time are exogenous. The Hansen's J statistic is reported along with the coefficient estimates and shows that there is no evidence against the validity of the instruments used in the regressions.

I first perform the GMM estimations for the period April 2000-November 2009. Second, I run rolling window regressions to determine whether the coefficient estimates have remained stable over time as well as to infer some underlying learning process for the market participants about the ECB's policy rule. In the robustness section, I also implement some recursive window regressions to check the sensitivity of the results to the applied methodology. The rolling window approach explores the stability of the coefficient estimates of the Taylor Rules using a constant number of observations but over different periods, whereas the recursive windows account for the impact of an additional information set that is gradually extended over time on the estimation of the policy rules.

4 Linear model estimations

In this section I present the estimation results for the Actual and Perceived policy reaction functions over the entire period: April 2000-November 2009. As previously mentioned the regressions are performed with the expectations variables for the quarter and year ahead, as well as for the one-quarter and one-year horizons respectively. The goal of using different horizons is to understand how the ECB reacts to the forecasts of macroeconomic fundamentals for different time periods.

4.1 Estimations for the quarter and year ahead horizons

This subsection presents the estimation results for the policy rules with the quarter and year ahead horizons. The coefficient estimates are reported in tables 2 and 3 for the Actual and Perceived Taylor Rules respectively.

Before turning to the estimations, it is important to bear in mind that if the ECB is on the hawkish side it will mainly focus on stabilizing inflation expectations assigning a smaller weight to the economic outlook, whereas if it is more dovish its policy will gear towards stabilizing real output growth rather than inflation expectations.[12]

[11] This approach is in line with Fourçans and Vranceanu (2004) for instance who use the first and second lags of the series as instruments in estimating a policy rule for the ECB.

[12] It is relevant to emphasize that the coefficients in the Taylor Rule embody both Central Bank preferences and structural characteristics of the economy. Thus, changes in the Taylor Rule coefficients reflect relative changes in the Central Bank preferences assuming that the structure of the economy is not altered.

Table 2: Actual Taylor Rule, 2000-2009

	Quarter ahead	Year ahead
ρ	0.9225***	0.9561***
	(0.0199)	(0.0125)
β_π	0.3419**	2.2607***
	(0.1428)	(0.4307)
β_y	0.8068***	2.3241***
	(0.1726)	(0.4493)
α	0.0098***	-0.0611***
	(0.0025)	(0.0131)
R^2	0.9826	0.9842
Observations	133	133
Hansen J-statistic	1.6143	1.2654
ADF Z(t)	-5.294***	-4.832***
PP Z(t)	-10.156***	-11.274***

Note: GMM estimates, HAC standard errors are computed with the Delta method and are denoted in parentheses. The table reports the long-run response coefficients. The regressions are performed for the specifications with the forecasts for the quarter ahead and the year ahead respectively. The Hansen J-statistic tests whether the over-identifying restrictions are satisfied. A statistically significant test shows evidence against the validity of the instruments. The ADF Z(t) and PP Z(t) refer to the Augmented Dickey-Fuller and Phillips-Perron statistics respectively. Both are used to determine whether the residuals contain a unit root. A statistically significant test shows evidence against the null hypothesis of unit root. For the ADF test 3 lags of the difference in the residuals have been used, while the number of lags used in the Phillips-Perron test are determined automatically based on Newey-West bandwidth selection. *** p<0.01, ** p<0.05, * p<0.1.

In a first step, based on the forecasts for the quarter ahead, the Central Bank responds positively and significantly to increases in the inflation forecasts but the Taylor Principle is not satisfied as the estimated inflation coefficient is below one in both policy rules.[13] In the event of a 1% increase in inflation expectations, the refi rate will be raised by 0.34% and 0.54% according to the actual and perceived policy rules respectively. One possible interpretation of this surprising result might be related to the fact that the ECB aims at stabilizing inflation in the medium and long terms and may not be worried by inflation deviations from its objective within the quarter ahead horizon. This explanation is further justified by the long and variable lags in the monetary policy transmission process which prevent the ECB from affecting inflation in the very short term.

Second, within the quarter ahead horizon, it seems that the Central Bank has more likely responded to the real output growth forecasts and has implemented a stabilizing policy for the economic outlook as indicated by the positive and significant coefficient estimates from both policy rules. A 1% increase in the output growth expectations will trigger an increase of 0.81% and 0.68% of the policy rate in the Actual and Perceived Taylor Rules respectively. Indeed, the importance of the economic outlook has been regularly underlined by the ECB Governing Council in the introductory statements to the regular press conferences. However, the ECB has not clarified the relative weight it assigns to the economic outlook in the policy strategy. Finally, the policy inertia coefficient estimates point out that the refi rate is adjusted only gradually to the desired target rate given the high level of sluggishness in the interest rates. In addition, the market participants have foreseen a similar degree of policy inertia as the actual one since the point estimates are

[13] In order to exert a stabilizing policy on inflation, the nominal interest rate should rise more than proportionally to increases in inflation expectations in order for the real interest rate to augment. This proposition is known as the Taylor Principle.

very close. Notice also that the professional forecasters have perceived the ECB to react more strongly to the inflation rather than to the real output growth expectations compared to the coefficient estimates from the Actual Taylor Rule.

Table 3: Perceived Taylor Rule, 2000-2009

	Quarter ahead	Year ahead
ρ	0.9122***	0.9060***
	(0.0110)	(0.0259)
β_π	0.5368***	2.1334***
	(0.1220)	(0.1793)
β_y	0.6761***	1.2351***
	(0.1055)	(0.2445)
α	0.0074***	-0.0343***
	(0.0020)	(0.0047)
R^2	0.9815	0.9828
Observations	133	133
Hansen J-statistic	1.7867	1.5091
ADF Z(t)	-4.361***	-3.894***
PP Z(t)	-10.633***	-10.306***

Note: GMM estimates, HAC standard errors are computed with the Delta method and are denoted in parentheses. The table reports the long-run response coefficients. The regressions are performed for the specifications with the forecasts for the quarter ahead and the year ahead respectively. The Hansen J-statistic tests whether the over-identifying restrictions are satisfied. A statistically significant test shows evidence against the validity of the instruments. The ADF Z(t) and PP Z(t) refer to the Augmented Dickey-Fuller and Phillips-Perron statistics respectively. Both are used to determine whether the residuals contain a unit root. A statistically significant test shows evidence against the null hypothesis of unit root. For the ADF test 3 lags of the difference in the residuals have been used, while the number of lags used in the Phillips-Perron test are determined automatically based on Newey-West bandwidth selection. *** p<0.01, ** p<0.05, * p<0.1.

As regards the estimations with the year ahead forecasts, one can observe an important difference in the magnitude of the estimated coefficients. Indeed, both the inflation and real output growth point estimates increase in both Taylor Rules when considering a longer forecast horizon. Importantly, tables 2 and 3 point out that the coefficient estimates are broadly in line with the empirical findings for the ECB in the literature.[14] This result is consistent with the interpretation that within the quarter ahead horizon the ECB has mainly focused on stabilizing real output growth rather than inflation expectations, the latter being its major concern in the policy relevant medium term horizon. The evidence for increasing Central Bank's responsiveness coefficients along with the forecasting horizon is further corroborated in Hamilton, Pruitt and Borger (2009). These authors have found increasing policy reaction coefficients with the forecasting horizon for the U.S. Federal Reserve. They have interpreted this finding as evidence for a gradual policy adjustment of the Central Bank to economic fundamentals.

Looking further ahead, the Actual and Perceived Taylor Rules show that the Taylor Principle is verified implying a stabilizing policy of the ECB on inflation expectations. This finding is in line with the ECB's objective of anchoring the inflation forecasts to its price stability objective in the medium to long terms. In addition, the positive and

[14]The reader could refer to Gorter, Jacobs and de Haan (2008), Fourçans and Vranceanu (2004), Gerdesmeier and Roffia (2004), Sauer et Sturm (2003) for instance. These authors estimate a reaction function for the ECB using a partial adjustment mechanism. Their estimates show that the Central Bank has exerted a stabilizing effect on inflation and on the output gap when using only a forward-looking specification of the policy rule.

significant point estimates of the output growth forecasts indicate that the Central Bank has implemented a stabilizing policy for the economic outlook as well. In the event of a 1% increase in the output growth expectations, the policy rate will be raised by 2.32% and 1.24% based on the actual and perceived estimates respectively. However, the estimated actual and perceived inflation coefficients are quite similar in both reaction functions. Thus, in the case inflation expectations increase by 1%, the Central Bank will augment the policy rate by 2.26% and 2.13% according to the actual and perceived policy rules correspondingly. These results show that the professional forecasters have perceived the ECB to respond relatively more strongly to the inflation than to the output growth forecasts in contrast with the findings for the actual reaction function. Indeed, the evidence points out that the Central Bank's responsiveness to the output growth forecasts is slightly higher than its reaction to the inflation forecasts according to the actual reaction function. As regards the policy inertia coefficient estimate, the latter has slightly decreased in the Perceived Taylor Rule while the Actual Taylor Rule points to a more sluggish adjustment of the policy rate compared to the results with the quarter ahead horizon. The following subsection presents the empirical findings with the one-quarter and one-year horizons.

4.2 Estimations for the one-quarter and one-year horizons

Tables 4 and 5 display the coefficient estimates of the policy rules when considering a horizon of one quarter and of one year respectively in the regressions.

Table 4: Actual Taylor Rule, 2000-2009 alternative model

	One-quarter horizon	One-year horizon
ρ	0.8775***	0.9000***
	(0.0290)	(0.0382)
β_π	0.2621**	0.7094***
	(0.1101)	(0.2075)
β_y	0.6174***	0.9718***
	(0.1024)	(0.3077)
α	0.0157***	-0.0004
	(0.0024)	(0.0051)
R^2	0.9801	0.9832
Observations	133	133
Hansen J-statistic	1.7440	1.5428
ADF Z(t)	-4.218***	-4.805***
PP Z(t)	-9.057***	-10.440***

Note: GMM estimates, HAC standard errors are computed with the Delta method and are denoted in parentheses. The table reports the long-run response coefficients. The regressions are performed for the specifications with the forecasts for a one-quarter and one-year horizon respectively. The Hansen J-statistic tests whether the over-identifying restrictions are satisfied. A statistically significant test shows evidence against the validity of the instruments. The ADF Z(t) and PP Z(t) refer to the Augmented Dickey-Fuller and Phillips-Perron statistics respectively. Both are used to determine whether the residuals contain a unit root. A statistically significant test shows evidence against the null hypothesis of unit root. For the ADF test 3 lags of the difference in the residuals have been used, while the number of lags used in the Phillips-Perron test are determined automatically based on Newey-West bandwidth selection. *** p<0.01, ** p<0.05, * p<0.1.

At a first glance, the evidence suggests that the empirical results previously obtained with the forecasts for the quarter and the year ahead remain qualitatively unaltered. Considering a horizon of one quarter in the regressions, the ECB responds positively to the inflation and output growth forecasts in line with the above findings. Moreover, the Tay-

lor Principle is not satisfied in both Taylor Rules as previously found. A 1% increase in inflation expectations will engineer a rise in the refi rate of about 0.26% and 0.40% in the Actual and Perceived Taylor Rules respectively. Regarding the output growth forecasts, in the event of a 1% increase in the latter, the policy rate will be raised by 0.62% and 0.60% according to the actual and perceived reaction functions correspondingly. Thus, in the short term the Central Bank puts a higher emphasis on stabilizing the economic outlook rather than inflation expectations which is in line with the earlier evidence. Besides, the professional forecasters have perceived the ECB to respond relatively more strongly to inflation rather than to output growth expectations compared to the estimates from the actual policy rule.

Table 5: Perceived Taylor Rule, 2000-2009 alternative model

	One-quarter horizon	One-year horizon
ρ	0.8836***	0.8960***
	(0.0130)	(0.0212)
β_π	0.3989***	1.1110***
	(0.1064)	(0.1563)
β_y	0.5984***	0.8324***
	(0.0642)	(0.2384)
α	0.0126***	-0.0061
	(0.0025)	(0.0052)
R^2	0.9798	0.9823
Observations	133	133
Hansen J-statistic	1.7504	1.5486
ADF Z(t)	-3.596***	-3.899***
PP Z(t)	-9.819***	-10.826***

Note: GMM estimates, HAC standard errors are computed with the Delta method and are denoted in parentheses. The table reports the long-run response coefficients. The regressions are performed for the specifications with the forecasts for a one-quarter and one-year horizon respectively. The Hansen J-statistic tests whether the over-identifying restrictions are satisfied. A statistically significant test shows evidence against the validity of the instruments. The ADF Z(t) and PP Z(t) refer to the Augmented Dickey-Fuller and Phillips-Perron statistics respectively. Both are used to determine whether the residuals contain a unit root. A statistically significant test shows evidence against the null hypothesis of unit root. For the ADF test 3 lags of the difference in the residuals have been used, while the number of lags used in the Phillips-Perron test are determined automatically based on Newey-West bandwidth selection. *** p<0.01, ** p<0.05, * p<0.1.

The Central Bank's responsiveness to both the inflation and output growth forecasts increases when considering the one-year horizon in the estimations, in line with the findings for the year ahead horizon. The size of the estimated coefficients is quite smaller compared to the evidence for the year ahead forecasts. In the event of a 1% increase in inflation expectations, the refi rate will be raised by 0.71% and 1.11% respectively according to the actual and perceived policy rules. As regards the output growth forecasts, a 1% increase in the latter will trigger a 0.97% and 0.83% rise in the policy rate for the actual and perceived reaction functions correspondingly. Therefore, the market participants perceive the ECB to respond more aggressively to inflation than to output growth expectations compared to the results from the actual reaction function. In contrast with the results for the year ahead horizon, the Taylor Principle is still not verified for the Actual Taylor Rule when including the one-year forecasts in the regressions. Regarding the Perceived Taylor Rule, the ECB implements a stabilizing policy for inflation expectations but the coefficient estimate is much smaller compared to the point estimate obtained with the forecasts for the year

ahead. Moreover, the Central Bank reacts more strongly to the output growth rather than to the inflation forecasts as the Actual Taylor Rule estimates point it out. The degree of policy inertia is broadly close to the previous results with some exceptions concerning the size of the estimated coefficients. In both policy rules the adjustment coefficient is slightly smaller than found earlier and the perceived point estimate increases a little when moving from the one-quarter to the one-year horizon.

The estimation results are broadly in line with the evidence reported in Sturm and Wollmershäuser (2008) for the forward-looking ECB Taylor Rule they estimate over the period 1999-2006 at the frequency of the Governing Council meetings. The estimated degree of policy inertia is of about 0.90 and is statistically significant at the 5% level. The coefficient estimates of the inflation and output growth forecasts are 1.63 and 1.52 respectively and are statistically significant at the 5% level. This suggests that the ECB responds strongly to the macroeconomic projections and that the Taylor Principle is satisfied. Even though these results are in general consistent with the evidence found in this paper, the magnitude of the inflation and output growth point estimates is smaller than the findings for the Actual Taylor Rule and to some extent for the Perceived Taylor Rule within the year ahead horizon. However, the reaction of the ECB to macroeconomic fundamentals estimated in Sturm and Wollmershäuser (2008) is well above the point estimates reported with the one-year forecast horizon.

Tables A.5 and A.6 in the appendix display the estimation results of the policy rules that contain a dummy variable for the period when the Governing Council has met more than once within a month. The regressions are performed for the quarter and the year ahead, as well as for the one-quarter and the one-year forecast horizons. Even though the estimated coefficients on the dummy variable are statistically significant, the number of meetings of the ECB within a month does not seem to have exerted an important effect on the refi rate setting given the very small magnitude of the estimated coefficients in both policy rules and for all forecast horizons. Besides, the dummy variable could capture the impact of other events on the policy rules occurring at the same time. The evidence for an increasing responsiveness of the Central Bank to macroeconomic fundamentals along the forecast horizon is robust to including the dummy variable for the Governing Council meetings in the regressions. For all horizons and Taylor Rules the policy inertia is qualitatively similar to the core results, even though the point estimates are slightly smaller than previously found. However, the ECB features a higher inflation responsiveness relative to its reaction to the output growth expectations in both Taylor Rules and for all forecast horizons than previously obtained. Conversely, in line with the baseline results the Taylor Principle is not satisfied with the quarter ahead and the one-quarter horizons in both policy rules. For the year ahead and the one-year horizons the ECB's policy seems to be stabilizing for inflation expectations.

To sum up, the empirical findings suggest that the Central Bank responds more strongly to the inflation and output growth expectations and implements an inflation stabilizing policy when considering the year ahead rather than the one-year forecasts in the regressions. The smaller responsiveness of the ECB with the one-quarter and the one-year forecasts could be related to the fact that the latter are not sufficiently forward-looking to engineer a stronger response of the ECB to the macroeconomic variables. The quarter and the year ahead forecasts are entirely forward-looking and are well suited to account for the lags in the monetary policy transmission process. They also seem to better correspond to the expectations formation process of the professional forecasters.

4.3 Actual and Perceived fitted policy rules

In this subsection I compare the fitted policy rate targets with the actual refi rates in both Taylor Rules.[15] This analysis will help to understand whether the ECB has accurately set the refi rate based on the recommendations stemming from the policy rules and will determine to what extent the market participants have correctly predicted the pattern of the policy rate within the sample.

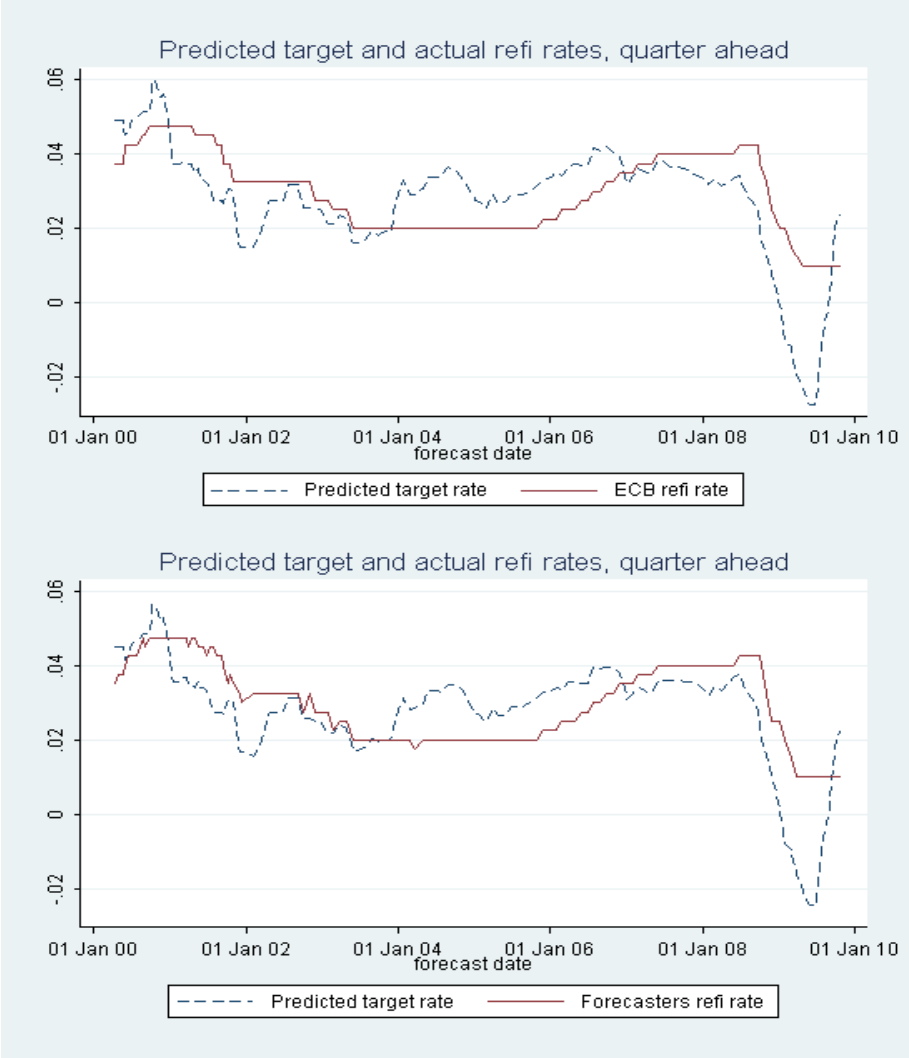

Figure 3: Actual and Perceived Taylor Rules, quarter ahead forecasts

Figure 3 displays the predicted policy rate target from the Actual and Perceived Taylor Rules when considering the forecasts for the quarter ahead in the estimations. At first sight, the figures point out that the predicted refi rates from both reaction functions are very similar. Indeed for both Taylor Rules, the pattern of the refi rate is broadly close to the predicted target rate but there are some important discrepancies as regards their magnitude for some periods. A first gap occurs after the financial market turmoil of 2000, when the predictions from the policy rules suggest that the ECB should have implemented sharper interest rate cuts and a few months earlier than in May 2001. Nevertheless, the

[15]The fitted target rate can be computed as indicated by equation (1) in the theoretical framework. It corresponds to the desired level of the refi rate that the Central Bank seeks to achieve. Notice that the refi rate fit would be closer to the policy rate when including the lagged refi rate in the prediction and therefore it is not reported.

Central Bank has reached the recommended target rate of 2% for the refi rate but only in June 2003. Importantly, since that date the Central Bank has maintained the policy rate at the level of 2% for a rather protracted period of time. The predicted target rates from both policy rules indicate that the ECB should have begun implementing a tightening cycle around January 2004. This result stands in contrast with December 2005 when the Central Bank started raising the refi rate for the first time. Hence, it seems that during a period of approximately two years the ECB has kept its policy rate at a too low level compared to the refi rate it should have set, has it followed the recommendations from the estimated Taylor Rules. This low level for the refi rate could have favored a risk taking behavior on the part of financial markets participants which could have fuelled a swift credit expansion thus contributing to the rapid growth of the housing market.

Finally, during the 2007-2009 financial slump the refi rate should have been cut earlier than in October 2008 and to a much deeper extent according to the estimated refi rate targets from both reaction functions. Indeed, the latter point out that the ECB should have started the policy easing cycle in August 2008. Given the size of the economic slump, the predicted target rates indicate that the Central Bank should have sharply cut the policy rate and thus reach the zero lower bound in January 2009.

However, the ECB has not lowered the refi rate to such an extent but has maintained it at the historically low level of 1% since May 2009. Finally, the predictions from both Taylor Rules show that the policy rate should have been raised quite rapidly in October 2009 to reach a level of around 2%. In fact, as the euro area has come out of the recession in the second quarter of 2009 the Central Bank should have resumed its firm commitment to price stability by entering a policy tightenting mode. If the ECB responds truly to economic fundamentals, it should have implemented gradual interest rate hikes since inflationary expectations have stabilized and have even started increasing slightly. Apparently, as the Central Bank has maintained the refi rate at the level of 1% it might have prioritized other policy goals such as securing the stability of the still fragile euro area banking system.

Figure A.1 in the appendix displays the predicted refi rate targets when considering a one-quarter horizon for the macroeconomic forecasts in the regressions. One can see that the predictions are very similar to the results obtained with the expectations for the quarter ahead. The fitted refi rates from both the actual and perceived policy rules point to the same recommendations for the key interest rate. The Actual and Perceived Taylor Rules indicate that the refi rate should have been increased from 2004 to 2007, while it should have been lowered earlier and to a further extent during the crises in 2001 and in 2008. The size of the predicted refi rate adjustments is similar to the one estimated with the forecasts for the quarter ahead even though the predicted refi rate cuts are slightly smaller within the one quarter horizon.

In a next step, I also compare the fitted target rates from the Actual and Perceived Taylor Rules when considering the forecasts for the year ahead in the regressions in figure 4. The graphs show that the previous results remain qualitatively unaltered when considering a longer forecast horizon in the estimation of both policy rules. The predicted target rates point out that the Central Bank has not sufficiently cut the refi rate in periods of recessions and financial turmoil and should have implemented a tighter policy stance from 2004 to 2007. Besides, the refi rate predictions of the Actual and Perceived Taylor Rules seem to be overall well aligned. However, there is an important difference in the magnitude of the predicted policy rate targets compared to the previous evidence for the quarter ahead horizon. Figure 4 points out that in periods of economic slump the refi rate should have been cut more sharply compared to the one implemented and the actual policy rule estimates point to even more negative interest rates especially during the recent crisis.[16]

[16]Gorter, Jacobs and de Haan (2009) do not find evidence for negative interest rates for the euro area during the crisis period. However, the three months euribor rate they use in the estimations is substantially

The predictions from the Perceived Taylor Rule are qualitatively similar but suggest that there should have been some smaller adjustments of the refi rate target. According to the in-sample forecasts of the actual reaction function, the level of the refi rate seems to be appropriate in November 2009, while the predictions from the perceived policy rule indicate that the interest rate should be raised to a level close to 1.75%.

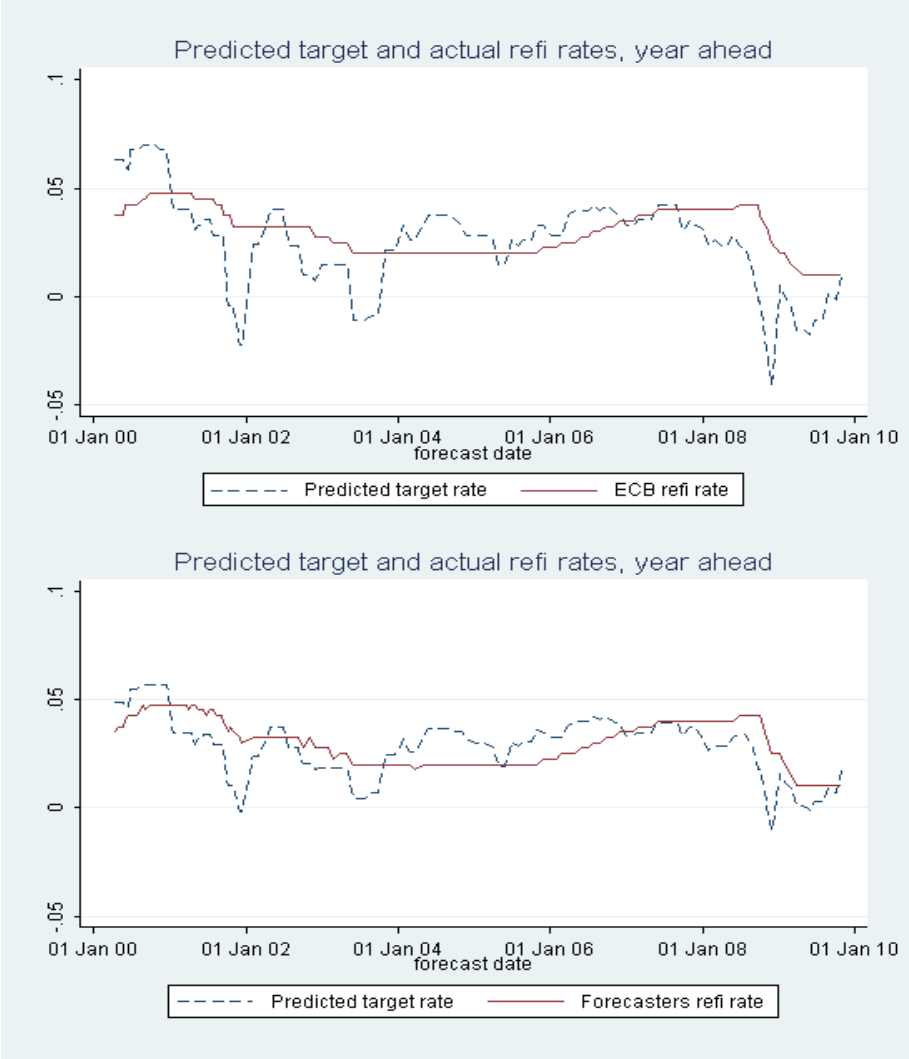

Figure 4: Actual and Perceived Taylor Rules, year ahead forecasts

Figure A.2 in the appendix displays the predicted refi rate targets when considering a one-year horizon in the regressions. One can see that the earlier predictions are qualitatively unaltered using an alternative forecast horizon in the estimations. The recommendations for the policy rate target from both reaction functions are similar. However, there is some difference regarding the magnitude of the recommended refi rate cuts compared to the findings with the year ahead horizon. The size of the policy rate adjustment is smaller when considering the one-year horizon in the estimations.

To sum up, the evidence from the predicted refi rate targets first points out that the patterns of the ECB's refi rate and the refi rate forecasted by the economists are broadly in line with the ones estimated with the policy rules, even though there are some important gaps in the magnitude of the predictions compared to the observed refi rates. Second, the results indicate that the professional forecasters have predicted a similar level for the

higher than the ECB's policy rate during the turmoil.

refi rate target than the one based on the Actual Taylor Rule. Third, the predictions of the policy rate are qualitatively unaltered from using different forecast horizons in the regressions.

In order to determine whether the estimated coefficients of the Taylor Rules have remained stable over time, the following section presents the estimation results of the rolling window regressions of the Actual and Perceived Taylor Rules. This analysis helps to determine whether the market participants have accurately estimated the responsiveness of the ECB to macroeconomic fundamentals over time and will unveil whether the policy rules have changed during the recent financial crisis. Thereby, the study will shed more light on the learning process of the ECB's policy rule on the part of the professional forecasters.

5 Rolling window estimations

In this part of the paper, I estimate the policy inertia, expected inflation and real output growth coefficients with rolling window regressions in order to determine whether the Central Bank's responsiveness to economic fundamentals has changed over time. This analysis will help to determine if a linear specification of the Taylor Rule is appropriate or whether one should consider a nonlinear model to account for a possible change in the coefficients of the policy reaction function for instance. The regressions are performed with the forecasts for the year ahead and the one-year horizons as they are more consistent with the standard view on the transmission of monetary policy impulses to the economy. They are also more in line with the horizon at which the ECB aims at stabilizing inflation expectations. The regressions are performed with the GMM method used for the estimation of the linear Taylor Rules presented in the previous section. The coefficients are estimated with a rolling window of 95 observations and a step that corresponds to each Governing Council meeting starting in April 2000.[17] The point estimates along with the corresponding 95% confidence intervals are displayed in the following graphs. Given that all estimations are performed in a real-time framework, this procedure is particularly valuable for understanding the monetary policy rule in light of the newly available information about macroeconomic fundamentals. Thereof, the results are especially useful for performing policy recommendations on the appropriate level of the policy rate in a real-time setting.

5.1 Coefficient estimates of policy inertia

Figure 5 points out that both the actual and perceived point estimates have remained overall stable during most of the estimation period. This evidence suggests that the ECB has not significantly changed the speed of adjustment of the policy rate until the second half of 2008. Second, the results indicate that there is a substantial sluggishness in the adjustment of the refi rate as the magnitude of the estimated coefficients is quite high, which is in line with the results of the previous section. The actual and perceived point estimates are close indicating that the market participants have perceived a broadly similar degree of policy inertia compared to the one estimated with the Actual Taylor Rule. Third, it is compelling to notice the change in the policy inertia coefficient estimates that has occurred since the peak of the financial crisis in October 2008. Indeed, one can see that both the actual and perceived point estimates have substantially changed since the tipping point of the turmoil. The policy inertia has decreased and the uncertainty associated with the estimated coefficients has broadened during the period of financial turbulence.

[17] The window of 95 observations is chosen in order to have sufficient observations for an accurate estimation of the response coefficients. The regressions have also been performed with a smaller window size but the results are not satisfactory.

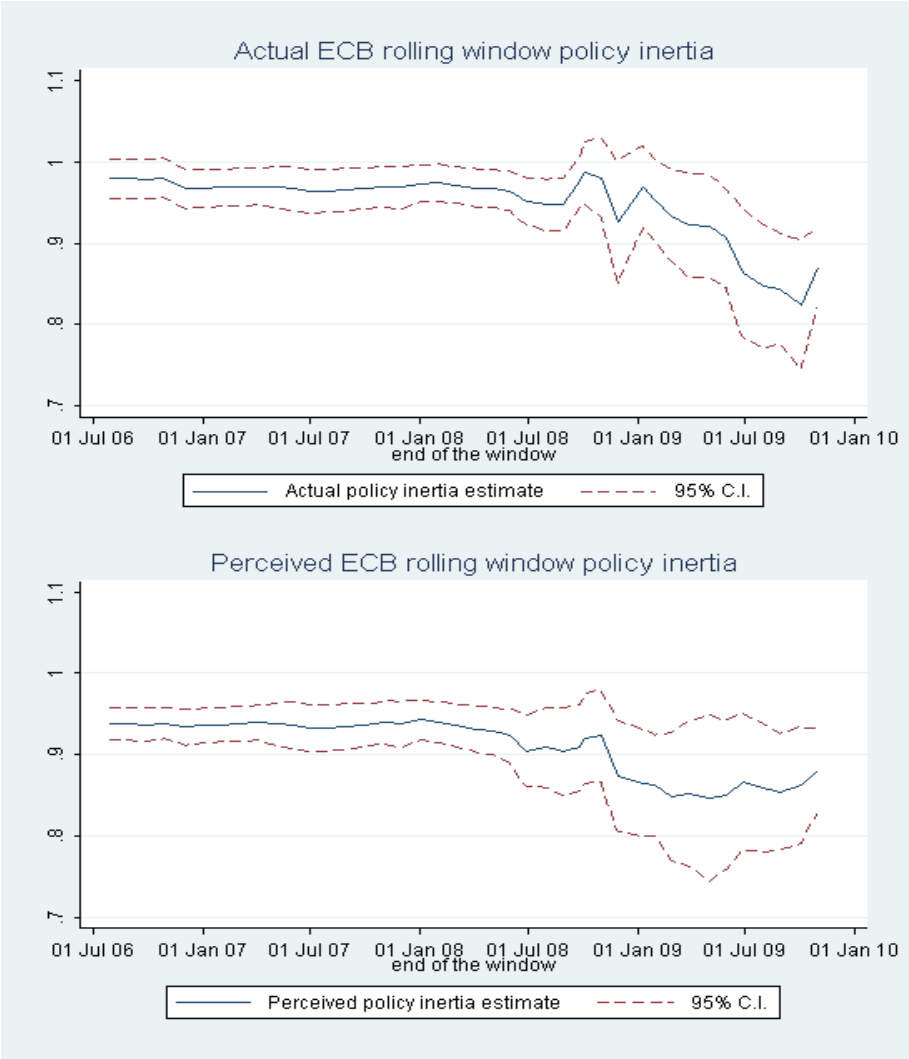

Figure 5: Policy inertia estimates, year ahead forecasts (rolling)

The empirical evidence thus accounts for the peak of the financial slump that has occurred in October 2008 after the bankruptcy of Lehman Brothers and the bailouts of several other worldwide large investment banks. The emergence of an exceptionally high systemic risk in the euro area banking sector has been followed by an unexpected reversal of the monetary policy tightening stance that the ECB has implemented in the following month. The Central Bank has thus reduced the refi rate by 50 basis points on 8 October 2008 in order to enhance the liquidity provision operations in the euro interbank market which has been adversely affected by massive liquidity shortages. This policy shift has been initially largely unexpected by the economists.

Since the tipping point of the financial crisis, the actual policy inertia coefficient has substantially decreased. This result is not surprising given the fact that the ECB has quickly brought down the refi rate to a historically very low level in order to prevent a broadening of the crisis and a further decline in economic activity. Besides, the jump as well as the higher uncertainty in the actual and perceived point estimates are very similar. Since October 2008, the actual coefficient estimate has gradually decreased reflecting the higher speed of implementation of the desired level of the refi rate that the ECB has undertaken.[18] The perceived policy inertia estimate has started decreasing since the peak of the crisis,

[18] From October 2008 to May 2009, the total reduction in the main policy rate has reached 325 basis points.

indicating that the professional forecasters have perceived a higher speed of adjustment of the ECB's refi rate as well. Furthermore, the confidence interval has widened substantially relative to the period before the unwinding of the crisis, possibly reflecting the broadening of macroeconomic uncertainty. The latter has been regularly emphasized by the Governing Council of the ECB on the monetary policy press conferences since October 2008.

Finally, figure A.5 in the appendix presents the policy inertia rolling window estimates using a one-year forecast horizon in the regressions. The figure points out that the previous results are qualitatively unaltered when considering an alternative horizon in the estimations. However, since the first half of 2009 the estimates from both Taylor Rules indicate that the policy inertia has decreased more substantially than estimated with the forecasts for the year ahead. The next subsection presents a similar analysis for the inflation forecast coefficient estimates.

5.2 Coefficient estimates of expected inflation

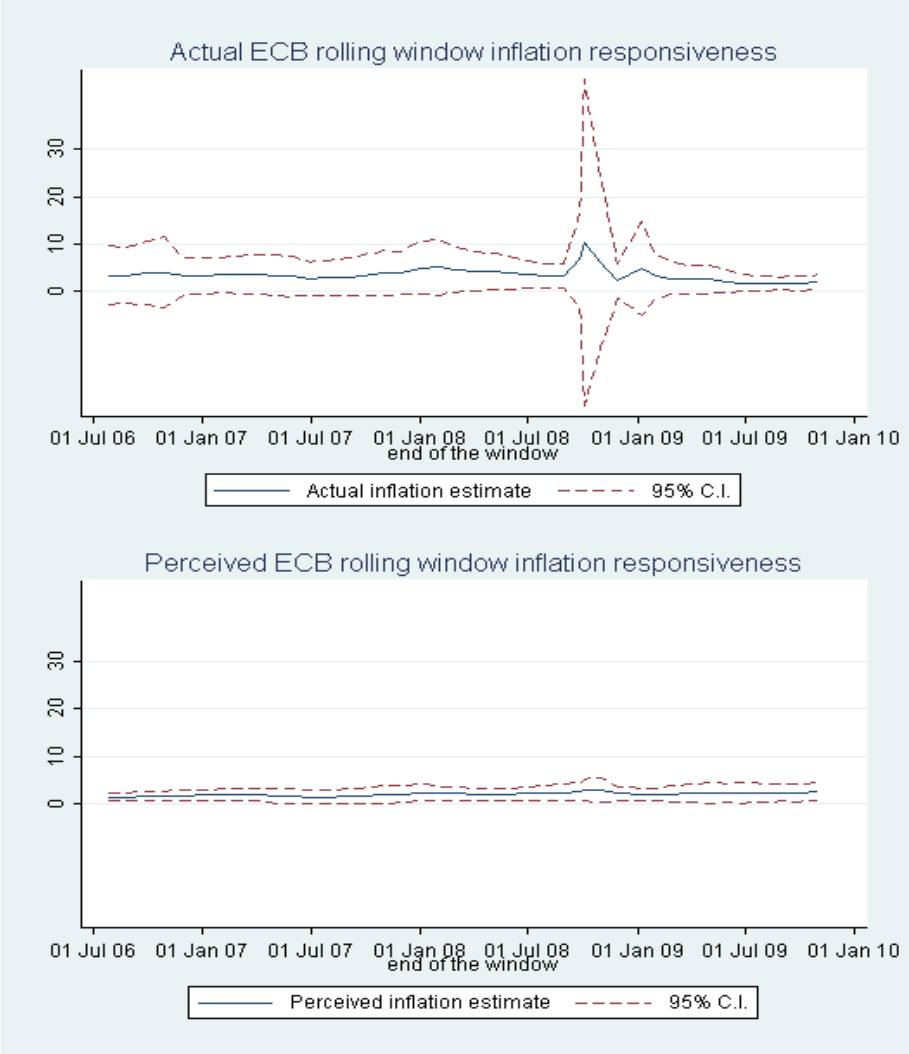

Figure 6: Inflation coefficient estimates, year ahead forecasts (rolling)

At a first sight, figure 6 indicates that the magnitude of the actual inflation coefficient estimate is relatively high but has not changed in an important way in the period before the financial crisis. The point estimate in the Actual Taylor Rule is also surrounded by a higher uncertainty compared to the narrower confidence interval of the perceived inflation

coefficient estimate. One cannot state that the actual and perceived point estimates are different before October 2008 because of the wide confidence interval of the estimated actual inflation coefficient, even though the perceived point estimate is smaller than the actual one. This evidence is consistent with the baseline results. As regards the perceived inflation coefficient, it has remained broadly unaltered during most of the period featuring only a slightly upward trend. The actual point estimate has risen substantially since the second half of 2007 thus reflecting a higher concern of the Central Bank about rising inflationary pressures. The perceived inflation coefficient has also increased in that period but to a lesser extent.[19] Overall, the observed gap in the actual and perceived coefficient estimates accounts for a hampered predictability of the size of the actual ECB's inflation responsiveness during most of the estimation period.

Furthermore, figure 6 reports an important change in the actual coefficient estimate which has occurred in the second half of 2008 and has peaked in October of that year precisely during the broadening of the financial crisis. The inflation point estimate has sharply jumped at the peak of the crisis and has reached a particularly high level. The actual inflation coefficient has swiftly increased in the second half of 2008 and then has rapidly declined after the tipping point of the turmoil. The observed sharp jump of the confidence interval reflects the exceptionally high level of uncertainty surrounding the coefficient estimate at the height of the financial turbulence. Thus, the observed behavior of the ECB's inflation responsiveness appears to be quite puzzling and should be attributed to the sudden reversal of the monetary policy stance that the ECB has implemented after the bankruptcy of Lehman Brothers.

Indeed, before the peak of the crisis the ECB was following a policy tightening strategy facing increasing inflationary pressures stemming essentially from commodity and food price increases. In addition, the ECB was also concerned about some possible second round effects on prices and wages which could have triggered off an inflation spiral. The Central Bank has even further tightened the euro area refinancing conditions by bringing up the refi rate to the level of 4.25% in July 2008, just two months before the tipping point of the financial turmoil. Then, on 8 October 2008, the ECB has sharply and unexpectedly reduced the refi rate within a coordinated policy action implemented jointly with other major Central Banks. Hence, the observed pattern of the ECB's policy rate largely reflects the fact that the broadening of the financial crisis in September 2008 has not been anticipated by the Governing Council of the ECB. Therefore, the puzzling spike of the actual inflation coefficient estimate might indicate the switching to a new monetary policy stance that the ECB has implemented at the height of the financial turbulence.

Importantly, the perceived inflation coefficient estimate points out that the professional forecasters have not anticipated the swift change of the ECB's monetary policy strategy in 2008. The point estimate has remained quite stable over most of the estimation period. It has increased just slightly after the July 2008 policy hike and then has declined only modestly in October 2008. Overall, the coefficient estimate has not been particularly affected by the crisis and is estimated very accurately compared to the larger confidence interval obtained for the actual inflation point estimate.

Finally, since January 2009, the actual inflation coefficient has gradually declined whereas the perceived one has remained stable. Nevertheless, it seems that the market participants have foreseen a similar inflation responsiveness of the Central Bank in the aftermath of the financial turmoil to the one found with the actual policy rule. This result points out that the ECB might have well anchored inflation expectations despite pursuing other policy goals in such a period of macroeconomic uncertainty. Figure A.6 in the appendix displays the rolling window inflation coefficient estimates with the one-year fore-

[19] The change in the estimated coefficients doesn't seem to be important at a first look because of the wide confidence interval for the actual point estimate observed at the peak of the crisis.

cast horizon. The estimated coefficients are broadly in line with the previous evidence even though they report a much smaller peak of the actual inflation point estimate during the crisis. Consistently with the findings for the year ahead horizon, the professional forecasters do not seem to have perceived a different inflation responsiveness of the Central Bank compared to the the actual policy rule estimates before the financial turmoil, even though the former point estimates are smaller than the latter. The perceived inflation reaction of the ECB has remained relatively stable during most of the period as previously found. In the final subsection I present the real output growth coefficient estimates from the rolling window regressions.

5.3 Coefficient estimates of expected GDP growth

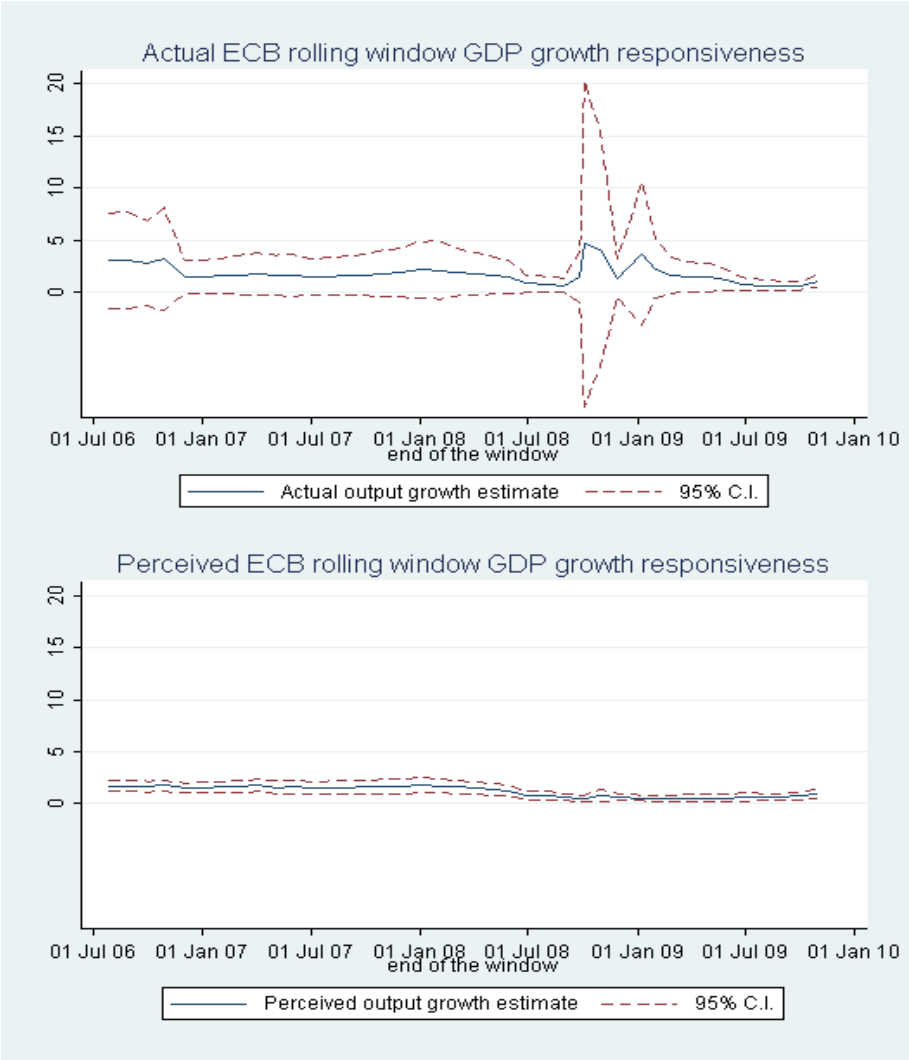

Figure 7: Output growth coefficient estimates, year ahead forecasts (rolling)

Figure 7 points out that the actual and perceived point estimates are broadly similar until the second half of 2008, except at the beginning of the estimation period. Besides, the output growth coefficient is estimated more accurately by the professional forecasters compared to the wider confidence interval obtained for the Actual Taylor Rule. This result is in line with the findings for the inflation coefficient estimates. Overall, it seems that the market participants have well perceived the actual ECB's responsiveness to the economic outlook in the first part of the estimation period. The figure points out that the perceived

growth coefficient has remained broadly stable until January 2008 and then has gradually declined along with the actual point estimate during the first half of 2008. This evidence probably reflects a higher concern of the ECB and the economists for the inflation outlook. During that period the Governing Council has focused on preventing a surge in inflation expectations by tightening the policy stance.

Moreover, there is an important change in the dynamics of the actual output growth coefficient during the broadening of the financial crisis and particularly in October 2008 as found for the policy inertia and inflation coefficients previously estimated. In that period the actual point estimate has considerably increased pointing to a relatively high concern of the ECB about the magnitude of the economic slump. However, the perceived output growth coefficient has changed only a little and is estimated quite accurately as indicated by the narrow confidence interval. As with the inflation reaction of the ECB, the market participants have not anticipated the swift change in the responsiveness of the Central Bank to the economic outlook. Until the beginning of 2009 the actual point estimate has followed a shifting pattern possibly reflecting the exceptional degree of uncertainty surrounding the monetary policy framework, whereas the perceived coefficient has remained rather stable.

Finally, the actual output growth coefficient has steadily declined since January 2009 as found for the actual inflation estimate, probably indicating a higher concern of the ECB about the fragility of the euro area banking system and its impact on the economic outlook. However, the perceived inflation and output growth coefficients have remained broadly stable in 2009 as the professional forecasters have possibly expected the ECB to respond strongly to macroeconomic fundamentals.

Figure A.7 in the appendix points out that the rolling window output growth estimates are broadly qualitatively similar when considering a one-year forecast horizon in the regressions even though the magnitude of the estimated coefficients is smaller. In addition, the observed peak in the actual coefficient estimate is more dampened than found with the year ahead forecast horizon. The perceived output growth point estimate is relatively stable before the broadening of the financial crisis which is in line with the evidence for the year ahead horizon. Both the actual and perceived coefficient estimates for the one-year horizon have decreased in 2009.

The empirical evidence points out that the estimated inflation and output growth forecasts reaction coefficients of the Perceived Taylor Rule are quite stable compared to the estimates of the actual policy rule. This suggests that the economists have not expected the magnitude of the quick and sharp reversal of the ECB's monetary policy stance since the tipping point of the crisis. This limited predictability of the ECB's responsiveness to macroeconomic fundamentals implies that the forecasters might not have well perceived the future ECB's interest rate pattern either. This finding indicates that the economists have probably not well foreseen how the ECB has adjusted the policy rate to face the broadening of the crisis while maintaining price stability as its overriding goal in the medium term.

On the one hand, the ECB has gradually increased the refi rate since December 2005 to alleviate rising inflationary pressures, while on the other hand it has sharply reversed the policy tightening since October 2008. Hence, without an explicit clarification of the monetary policy strategy the ECB might have sent mixed signals to the relevant market participants, which may account for the hampered predictability of the inflation and output growth coefficients since October 2008.[20]

[20]The limited transparency of the ECB is extensively analyzed in Geraats P. (2008) and Geraats P., Giavazzi F., Wyplosz C. (2008). The authors emphasize that the markets have well managed to predict the next policy move of the ECB but have fallen short into predicting the medium to long term policy orientation. They conclude that the ECB should be more transparent in order to improve the predictability of its future policy actions by the relevant market participants. In particular, the authors point out that the ECB would have benefited from providing future guidance to the markets by publishing its expected future interest rate path.

To sum up, the evidence presented in this section points out that the policy response coefficients have more likely changed over time and the Actual Taylor Rule has been particularly affected by the financial turmoil in 2008. The observed spikes in the inflation and output growth point estimates indicate that the ECB has swiftly and sharply reversed its policy stance facing an environment of exceptional macroeconomic uncertainty with a high level of systemic risk in the banking sector. The results point out that there is more uncertainty surrounding the coefficient estimates of the Actual Taylor Rule within the year ahead than with the one-year horizons. Even though the professional forecasters have accurately estimated the Central Bank's responsiveness to macroeconomic fundamentals before the crisis, they have not well anticipated the policy reversal at the peak and in the aftermath of the financial turmoil. Thereby, the following section is focused on analyzing more in-depth the impact of the financial slump on the estimated policy reaction functions.

6 Estimation with time dummies

In view of the evidence from the rolling window results, in this section I investigate the size of the effect of the tipping point of the financial crisis and the subsequent broadening of the turmoil on the main policy rate of the ECB. For this purpose, I estimate the above Actual and Perceived Taylor Rules by including a time dummy that accounts for the peak of the crisis occurring on 8 October 2008, as well as a second time dummy for the period of economic slump, from 8 October 2008 until 7 May 2009. The final date corresponds to the end of the sharp policy rate cuts the ECB has implemented and coincides with the end of the economic recession according to the Euro Area Business Cycle Dating Committee. The coefficient estimates for the actual policy rule are presented in table 6.

Table 6: Actual Taylor Rule, 2000-2009 crisis dummies

	Year ahead 1	Year ahead 2	One-year horizon 1	One-year horizon 2
ρ	0.9606***	0.9584***	0.9045***	0.9638***
	(0.0135)	(0.0125)	(0.0444)	(0.0066)
β_π	3.4155***	2.2627***	0.8849***	0.4924
	(0.8312)	(0.2942)	(0.1894)	(0.3782)
β_y	2.0166***	1.5507***	0.9379**	1.2639***
	(0.5326)	(0.4012)	(0.3716)	(0.4493)
Crisis' peak	-0.1887		-0.0369	
	(0.1414)		(0.0240)	
Crisis		-0.0752***		-0.0779***
		(0.0229)		(0.0277)
α	-0.0748***	-0.0411***	-0.0031	-0.0006
	(0.0204)	(0.0101)	(0.0067)	(0.0110)
R^2	0.9839	0.9878	0.9840	0.9863
Observations	133	133	133	133
Hansen J-statistic	0.5300	1.2183	1.5292	1.6690
ADF Z(t)	-4.897***	-5.104***	-4.578***	-4.910***
PP Z(t)	-11.540***	-13.473***	-10.635***	-12.206***

Note: GMM estimates, HAC standard errors are computed with the Delta method and are denoted in parentheses. The table reports the long-run response coefficients. The regressions are performed for the specifications with the forecasts for the year ahead and the one-year horizons respectively. The variable "Crisis' peak" is a dummy that takes the value 1 for 8 October 2008, while the variable "Crisis" is a dummy for the period of the financial turmoil from 8 October 2008 until 7 May 2009. The Hansen J-statistic tests whether the over-identifying restrictions are satisfied. A statistically significant test shows evidence against the validity of the instruments. The ADF Z(t) and PP Z(t) refer to the Augmented Dickey-Fuller and Phillips-Perron statistics respectively. Both are used to determine whether the residuals contain a unit root. A statistically significant test shows evidence against the null hypothesis of unit root. For the ADF test 3 lags of the difference in the residuals have been used, while the number of lags used in the Phillips-Perron test are determined automatically based on Newey-West bandwidth selection. *** p<0.01, ** p<0.05, * p<0.1.

The table points out that the peak of the crisis has exerted an important negative effect

on the policy rate as one could have expected in light of the previous results. However, even though the effect of the dummy variable on the refi rate is negative for both forecast horizons, the coefficient estimates are not statistically significant. Besides, when controlling for the tipping point of the financial turmoil the responsiveness of the Central Bank to macroeconomic fundamentals changes slightly compared to the baseline results. As regards the estimates for the year ahead horizon, the ECB features a higher inflation responsiveness relative to its reaction to the output growth forecasts while the policy inertia coefficient is in line with the previous evidence. Concerning the one-year forecast horizon, the inflation responsiveness coefficient has increased as well but the Central Bank still reacts more strongly to the economic outlook rather than to inflation expectations consistently with the baseline results. The policy inertia coefficient is not altered from including the dummy variable in the regressions for the year ahead and the one-year horizons.

Furthermore, the size of the impact of the period of financial crisis on the refi rate is particularly important and the coefficient estimates are negative and statistically significant. The point estimates indicate that the magnitude of the crisis is quite similar for the two forecast horizons and show that the financial slump has lead to a policy rate cut of approximately 7.5% and 7.8% on average over that period for the year ahead and the one-year horizons respectively. In addition, the estimated inflation coefficient is the same as found with the baseline model and the Central Bank responds less strongly to the output growth expectations within the year ahead forecast horizon. The estimated policy inertia is consistent with the earlier evidence. Regarding the one-year horizon, the inflation point estimate is not significant and the ECB reacts more strongly to the economic outlook which is in line with the results from the baseline regression. The Taylor Principle is not verified with the one-year forecasts as previously found. Besides, the policy inertia coefficient estimate suggests that there is a higher sluggishness in the adjustment of the refi rate compared to the earlier findings for the one-year horizon. Table 7 displays the estimated results for the perceived policy rule.

The evidence from table 7 suggests that the impact of the financial crisis on the policy rate is more dampened compared to the results obtained for the Actual Taylor Rule. As regards the peak of the crisis, the effect on the refi rate is positive and not significant for both forecast horizons, which stands in contrast with the negative estimates found for the actual policy rule. In addition, the responsiveness of the Central Bank to macroeconomic fundamentals and the degree of policy inertia are qualitatively unaltered from the baseline results when including the dummy variable for the crisis' peak in the regressions. However, the size of the ECB's reaction to inflation expectations is smaller relative to the output growth forecast point estimates in both horizons.

Concerning the period of financial turmoil, the effect on the refi rate is negative but the size of the estimated coefficients is smaller compared to the results found for the actual reaction function and is significant only for the year ahead horizon. This evidence points out that the economists have not foreseen the effect of the sharp reversal of the policy stance the ECB has implemented on 8 October 2008 and in the subsequent period on the refi rate. For the year ahead horizon the crisis dummy indicates that in that period the interest rate has been lowered by approximately 1.9%, while for the one-year horizon the financial slump has lead to a reduction of the policy rate by only 0.9% with an estimated coefficient that is not statistically significant. The inflation and output growth point estimates, as well as the degree of policy inertia are qualitatively similar to the baseline results, even though it seems that the ECB has slightly increased its responsiveness to inflation relative to output growth expectations. The Taylor Principle is verified with the one-year forecasts which is in line with the findings of section 4.

Table 7: Perceived Taylor Rule, 2000-2009 crisis dummies

	Year ahead 1	Year ahead 2	One-year horizon 1	One-year horizon 2
ρ	0.8942***	0.9065***	0.8929***	0.9118***
	(0.0247)	(0.0198)	(0.0218)	(0.0106)
β_π	2.0037***	2.0705***	1.0213***	1.1697***
	(0.2148)	(0.1614)	(0.1776)	(0.1581)
β_y	1.2385***	1.0180***	0.8395***	0.8105***
	(0.2095)	(0.1957)	(0.2501)	(0.1496)
Crisis' peak	0.0319		0.0189	
	(0.0203)		(0.0132)	
Crisis		-0.0186***		-0.0086
		(0.0049)		(0.0061)
α	-0.0317***	-0.0276***	-0.0047	-0.0068*
	(0.0033)	(0.0043)	(0.0047)	(0.0041)
R^2	0.9821	0.9839	0.9822	0.9832
Observations	133	133	133	133
Hansen J-statistic	1.0109	1.5122	1.5197	1.5753
ADF Z(t)	-3.882***	-3.435***	-4.034***	-3.919***
PP Z(t)	-9.873***	-10.986***	-10.639***	-11.370***

Note: GMM estimates, HAC standard errors are computed with the Delta method and are denoted in parentheses. The table reports the long-run response coefficients. The regressions are performed for the specifications with the forecasts for the year ahead and the one-year horizons respectively. The variable "Crisis' peak" is a dummy that takes the value 1 for 8 October 2008, while the variable "Crisis" is a dummy for the period of the financial turmoil from 8 October 2008 until 7 May 2009. The Hansen J-statistic tests whether the over-identifying restrictions are satisfied. A statistically significant test shows evidence against the validity of the instruments. The ADF Z(t) and PP Z(t) refer to the Augmented Dickey-Fuller and Phillips-Perron statistics respectively. Both are used to determine whether the residuals contain a unit root. A statistically significant test shows evidence against the null hypothesis of unit root. For the ADF test 3 lags of the difference in the residuals have been used, while the number of lags used in the Phillips-Perron test are determined automatically based on Newey-West bandwidth selection. *** p<0.01, ** p<0.05, * p<0.1.

The estimations with the crisis dummies as well as the evidence from the rolling window regressions reveal that the Actual and to a lesser extent the Perceived Taylor Rules have been particularly affected by the broadening of the financial turmoil since October 2008. Given that the ECB has quickly and sharply adjusted the policy rate to prevent a further decline in economic activity, it might have responded differently to macroeconomic fundamentals during this period by entering a crisis regime. During the financial turbulence, the Central Bank has focused on improving the liquidity provision of the interbank market and on restoring the orderly functioning of financial markets. Besides, the policy implemented seems to have affected the interest rate setting framework of the ECB. This evidence is in line with the view of Smets (2009) who has stated that the separation principle has been breached because the broadening of the financial turmoil has affected the interest rate setting strategy of the ECB. The rolling window estimates have shown that the inflation and output growth coefficient estimates of the Actual Taylor Rule have decreased in that period as the Governing Council's policy has geared towards securing the stability of the euro area financial system. The unconventional policy measures implemented by the ECB during the crisis are extensively documented in Wyplosz (2010). The author highlights that the refi rate cuts undertaken only at the height of the turmoil could be related to the rising commodity and food prices in the fall of 2007 and the specific prioritization of the price stability objective in the ECB's mandate.

7 Robustness analysis

The goal of this section is to conduct a sensitivity analysis of the results presented in sections 4 and 5. For this purpose, I adopt an alternative methodology to estimate the response coefficients of the policy rules over time and I also include different forecasts of economic fundamentals in the regressions. In a first step, I adopt a recursive window

approach in estimating the Actual and Perceived Taylor Rules using the forecasts for the year ahead and the one-year horizons. Then, I estimate the policy rules using Consensus Economics Forecasts (CEF) of inflation and output growth in order to determine whether the results are sensitive to the expectations variables used.[21]

With the recursive window procedure, the starting date of the regressions is fixed and the estimation range is progressively extended as the available information set increases over time. With this approach I investigate to what extent the policy rules coefficients are affected by an additional information on macroeconomic fundamentals. As for the rolling window methodology, I apply a step of one policy meeting in the estimations to track as closely as possible the monetary policy decision process. The coefficient estimates are displayed in figures A.8 to A.10 in the appendix for the year ahead forecast horizon. The recursive point estimates are in general in line with the results found with the rolling window approach. In particular, the actual and perceived policy inertia estimates are of a similar size and are quite stable before the financial crisis. Since the tipping point of the turmoil the estimated coefficients tend to decrease but to a much smaller extent than found with the rolling window regressions. As regards the inflation response coefficient, the professional forecasters have not perceived a different responsiveness of the Central Bank from the actual one, even though the perceived point estimate is smaller than the actual coefficient as found with the rolling window methodology. The magnitude of the actual and perceived recursive point estimates is similar to the one estimated with the rolling window approach but the actual inflation reaction of the ECB is more dampened at the peak of the crisis than found earlier. As regards the output growth coefficient, the actual point estimate is not different from the perceived coefficient in the recursive regressions and its magnitude is relatively small at the broadening of the crisis compared to the results with the rolling windows. In line with the baseline results, the actual inflation and output growth coefficients have followed a downward pattern since 2009 as the Central Bank might have prioritized other goals such as maintaining the stability of the financial system. Importantly, the perceived coefficient estimates are more stable than the actual ones because the market participants have not expected the swift reversal of the ECB's policy during the financial turmoil. Consistently with the baseline results, the main message brought by the Actual Taylor Rule is that since the financial slump the ECB has adjusted more frequently the refi rate to the desired target level and has weakened its inflation and output growth responsiveness. Regarding the Perceived Taylor Rule, the estimated policy inertia has decreased since the peak of the crisis but there is no evidence that the Central Bank has responded less strongly to macroeconomic fundamentals. This is in line with the findings from the rolling window regressions.

The recursive window estimates for the one-year forecast horizon are also broadly consistent with the results from the one-year rolling window regressions as shown in figures A.11 to A.13 in the appendix. In particular, the actual and perceived policy rules point out that the policy inertia of the ECB has decreased and its responsiveness to the inflation and output growth expectations has weakened since the peak of the financial turmoil. In general, the magnitude of the recursive window coefficients is quite similar to the one estimated with the rolling window regressions for the one-year horizon. There is no evidence that the actual and perceived coefficients are different, even though the point estimates from the Perceived Taylor Rule are smaller than the actual ones before the crisis and for both horizons.

The observed gaps between the actual and perceived coefficient estimates can be at-

[21] The Consensus Economics Forecasts are reported for the current year and the year ahead. They are also provided in real-time and are not revised. The forecasts correspond to the average projections of inflation and real GDP growth which are performed by a panel of professional forecasters for the euro area. The author is particularly grateful to the Swiss National Bank which kindly provided access to the Consensus reports.

tributed to the communication policy of the ECB which is rather opaque as regards the relative weighting scheme of the inflation and output growth stabilization objectives in its policy strategy. In line with this view, during the January 2004 introductory statement, Mr.Trichet has emphasized the following: *"...we are not the prisoner of an equation, we are not the prisoner of a system of equations, we are not the prisoner of an algorithm which would dictate our conduct and behavior. We take, I would say, all pertinent information-all pertinent analyses-and we make a judgment [...] Because by anchoring a low level of inflation in the years to come, and not in the medium term but also in the long term, we pave the way for this favorable financial environment which is conducive to growth."* This constrained discretion approach points out that the Governing Council avoids any pre-commitment to a future course of policy actions but intends to be perfectly transparent about its long-run goal of price stability. Thereby, the ECB has not clarified the way it takes due account of the economic outlook while pursuing its overriding objective.

The estimations with the Consensus Economics Forecasts are presented in tables A.7 and A.8 in the appendix. At a first glance, some of the results are broadly consistent with the previous evidence for the Perceived Taylor Rule even though there are some differences in the size of the estimated coefficients. Concerning the Actual Taylor Rule, the estimates suggest that the ECB has responded more strongly to the inflation rather than to the output growth expectations when considering the forecasts for the year ahead compared to the baseline results. However, the inflation point estimate is similar to the one obtained with the investment bank's forecasts. Regarding the forecasts for the one-year horizon, the results are in general close to the baseline evidence for the Actual Taylor Rule except for the inflation responsiveness coefficient which is negative but not significant. Besides, the CEF estimates of the policy inertia and output growth coefficients are in line with the evidence for the Perceived Taylor Rule except that the Taylor Principle is not satisfied for the one-year horizon. Figures A.3 and A.4 in the appendix display the fitted policy rate targets using the consensus data for different forecast horizons. The predicted target refi rates fully corroborate the results obtained with the investment bank's forecasts for both the Actual and Perceived Taylor Rules. In particular, the graphs point out that the refi rate should have been raised earlier than in December 2005 and during the recent crisis the policy rate should have been cut more in advance and to a lower level than the one implemented. The estimations with the crisis dummies, which are not reported in the paper reveal that the peak of the crisis has exerted a negative but not significant effect on the refi rate except for the Perceived Taylor Rule within the year ahead horizon. In the period of financial slump, from October 2008 to May 2009, the policy rate has been particularly affected by the crisis as the estimated coefficients of the dummy variables are negative and significant except for the Actual Taylor Rule within the one-year horizon. This evidence corroborates the previous results for the regressions with the investment bank's forecasts.

The rolling and recursive window regressions with the consensus forecasts are consistent with the previous evidence for the policy inertia point estimates. However, the reaction of the ECB to the inflation and output growth forecasts is quite dampened during the recent crisis in both policy rules.[22] Besides, the Consensus forecasters have estimated a similar responsiveness of the Central Bank to macroeconomic fundamentals to the one obtained with the actual policy rule and the uncertainty surrounding the point estimates is of the same size. Since 2009 the inflation and output growth point estimates have declined which is consistent with the baseline results for the Actual Taylor Rule.

I have also estimated the policy rules with the Economic Sentiment Indicator (ESI), expressed in percentage point deviation from its long-run average of 100, as an alternative

[22]The rolling and recursive window regressions with the CEF data are not reported in the paper to save some space.

measure of the private sector expectations of the euro area economic outlook.[23] The ESI is a leading business cycle indicator and the ECB often refers to this variable when assessing the private agents' expectations on the future economic conditions in the monetary union. Tables A.9 and A.10 in the appendix report the coefficient estimates for the Actual and Perceived Taylor Rules for different forecast horizons. In both policy rules the ESI growth point estimate is positive and statistically significant even though the magnitude of the coefficients is smaller compared to the reaction of the ECB to the output growth forecasts. The size of the inflation point estimate is close to the one obtained in the baseline model for the quarter ahead and the one-quarter horizons. The previous evidence for increasing Central Bank's responsiveness to inflation expectations along the forecast horizon is robust to using the ESI growth as an alternative measure of the euro area business cycle forecasts, except for the Actual Taylor Rule with the year ahead forecasts. Importantly, the ECB features a higher inflation than business cycle responsiveness and the Taylor Principle is not fulfilled except for the Perceived Taylor Rule with the year ahead horizon. The Central Bank also puts a slightly higher emphasis on the deviation of the ESI from its average when considering the longer forecast horizon for the Actual Taylor Rule. As regards the Perceived Taylor Rule, there is evidence in the opposite direction. The estimated degree of policy inertia suggests an important sluggishness of the refi rate whose magnitude is broadly in line with the baseline findings. Regarding the predicted policy rate target, the results are fully in line with the earlier evidence. In particular, the latter point out that the ECB should have raised the refi rate during the period 2004-2007 and should have cut it earlier and to a deeper extent in periods of crisis as previously found.[24] The evidence thus indicates that the ECB does not react as strongly to the ESI as to the output growth expectations, however, the latter provides a relevant indication on the expected developments in the euro area economy.

Tables A.11 and A.12 report the estimation results with the consensus inflation expectations and the deviation of the ESI from its long-run average included as regressors in the Taylor Rules. The tables point out that the ECB responds positively and significantly to the ESI growth rate even though the estimated magnitude is smaller compared to its reaction to the output growth forecasts. The Central Bank also reacts more strongly to the inflation forecasts relative to the ESI but the Taylor Principle is not satisfied in neither horizon. The inflation responsiveness of the ECB is in general smaller than previously obtained except with the one-year horizon for both policy rules. The estimated degree of policy inertia is well in line with the previous results for the consensus forecasts. The size of the ESI coefficient estimates is similar to the one estimated with the inflation forecasts from the investment bank. The rather small reaction of the ECB to inflation expectations could be explained by the important informational content of the ESI deviation from its average compared to the real GDP growth forecasts. Finally, the predicted policy rate targets are consistent with all previous results on the recommended refi rate target and hence are not reported. Overall, the evidence suggests that the Central Bank should have cut more quickly and sharply the refi rate during crises and should have raised more in advance and to a further extent the policy rate in periods of economic upturn.

The sensitivity analysis presented in this section shows that the actual and perceived response coefficients are likely to have changed over time regardless of the methodology and the data used in the estimations. However, the size of the change in the ECB's behavior during the financial crisis is sensitive to the forecast variables and to the horizons considered. A robust result to the data and to the estimation methodology is the finding that since the peak of the turmoil the degree of policy inertia has decreased in both policy

[23] The ESI is a weighted average of the confidence indicators in the industry, services, construction, retail trade and consumers' sectors published by the European Commission on a monthly basis.

[24] As the graphs of the fitted target rates are very similar to the ones obtained with the baseline variables they are not reported in the paper.

rules. Some of the results have also shown evidence that the Central Bank has responded differently to macroeconomic fundamentals since the broadening of the financial crisis. Therefore, it is worth investigating more thoroughly the specification of the policy rules within an appropriate nonlinear model.

8 Conclusion

This paper has brought new insights on understanding the predictability of the monetary policy stance of the European Central Bank through the eyes of the professional forecasters from a large investment bank. The empirical evidence points to the following main results.

First, within the Actual and Perceived Taylor Rules framework the professional forecasters have accurately predicted the pattern of the refi rate even though they have perceived more properly the policy rate increases than the refi rate cuts. The predictions of the refi rate target from both policy rules are well aligned and point out that the ECB has maintained the policy rate at a too low level for a protracted period from 2004 until 2007. Thereby, the Central Bank might have favored a risk taking behavior which could have fueled the rapid expansion of the housing market in the euro area. Besides, the estimates indicate that in periods of financial turmoil the ECB should have cut the refi rate earlier and to a deeper extent than the adjustments it has implemented. There is also evidence that the responsiveness of the Central Bank to inflation and output growth expectations increases along the forecast horizon in both Taylor Rules. This result is robust to the expectations variables considered in the estimations. The responsiveness of the ECB to macroeconomic fundamentals is stronger with the year ahead than with the one-year horizon which suggests that the former are possibly more in line with the expectations formation process of the professional forecasters.

Second, the rolling window regressions show that the estimated coefficients have remained broadly stable until the second half of 2008. There is evidence that the reaction of the Central Bank to macroeconomic fundamentals has changed after the bankruptcy of Lehman Brothers as the ECB has focused on preventing a further decline in economic activity. The perceived coefficients are broadly similar to the actual ones given the wide confidence intervals of the Actual Taylor Rule, even though the economists have estimated a smaller policy inertia and ECB's reaction to the inflation and output growth expectations. The results from the estimations with the one-year horizon are qualitatively similar to the evidence for the year ahead forecasts, however, the magnitude of the estimated coefficients is smaller with the former. The estimations with the time dummies point out that during the broadening of the crisis the refi rate has been cut in an important way especially in the regressions with the year ahead horizon.

Third, the recursive window estimates corroborate the previous findings. Some of the results are also qualitatively unaltered from using Consensus Economics Forecasts and the ESI growth rate, even though there are some differences in the size of the point estimates. It is interesting to note that both the rolling and recursive window techniques point to a decreasing pattern of the inflation and real output growth coefficients since January 2009 for the actual policy rule. As previously highlighted, this finding might suggest a higher concern of the Central Bank about the stability of the banking system, which has been affected by an unforeseen level of systemic risk. An interesting topic would be to further investigate to what extent the financial stability issue could affect the monetary policy strategy of the ECB, and particularly the overriding price stability mandate in the medium and longer terms.

The analysis performed in the paper points to some gaps between the actual and perceived coefficient estimates of inflation and real output growth expectations. The latter indicate that the learning process about the ECB's policy reaction function can be fur-

ther improved by enhancing the transparency and communication strategy of the Central Bank. Regularly, the ECB has justified that this limited openness is implied by the very precise and simple policy framework: the delivery of price stability over the medium term. However, I would suggest the following policy recommendations to improve the effectiveness of the European monetary policy. First, the ECB should clarify the weight it assigns to the economic outlook and to the stability of the banking system when deciding on the appropriate level of the refi rate. Second, the Central Bank should publish its main macroeconomic projections at the frequency of the Governing Council meetings in order to enhance the predictability of its policy decisions by the relevant economic agents. Finally, the ECB would benefit from publishing the conditional future refi rate path along with the associated uncertainty of the point forecasts. This practice will not tie the hands of the Central Bank to a predetermined course of actions because the predicted future levels of the policy rate are conditional on the expected inflation and economic developments in the euro area. Instead, by anchoring the expectations of the private sector to the Central Bank's forecasts this enhanced transparency would help to credibilize the low inflation commitment of the ECB in the medium and longer terms. Lastly, the estimation results suggest that the monetary policy stance has been severely challenged by the recent financial crisis. Particularly, the broadening of the turmoil has not been anticipated by the Central Bank neither by the professional forecasters. Hence, in a future work it would be relevant to further analyze the responsiveness of the Central Bank to macroeconomic fundamentals within an appropriately designed regime switching model.

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9 Appendix

9.1 Variables used in the estimations

Table A.1: List of variables

Variable	Description
i_{t+1}	Refi rate set by the ECB at its policy meeting in period $t+1$.
$E_t i_{t+1}$	Refi rate point forecast reported by the investment bank's economists in period t for the refi rate decision in period $t+1$.
$E_t \pi_q$	Inflation point forecasts of the investment bank's economists for the current quarter horizon.
$E_t \pi_{q+1}$	Inflation point forecasts of the investment bank's economists for the quarter ahead horizon.
$E_t \bar{\pi}_q$	One-quarter inflation point forecasts horizon of the investment bank's economists.
$E_t \pi_y$	Inflation point forecasts of the investment bank's economists and Consensus Economics for the current year horizon.
$E_t \pi_{y+1}$	Inflation point forecasts of the investment bank's economists and Consensus Economics for the year ahead horizon.
$E_t \bar{\pi}_y$	One-year inflation point forecasts horizon of the investment bank's economists and Consensus Economics.
$E_t y_q$	Real GDP growth point forecasts of the investment bank's economists for the current quarter horizon.
$E_t y_{q+1}$	Real GDP growth point forecasts of the investment bank's economists for the quarter ahead horizon.
$E_t \bar{y}_q$	One-quarter real GDP growth point forecasts horizon of the investment bank's economists.
$E_t y_y$	Real GDP growth point forecasts of the investment bank's economists and Consensus Economics for the current year horizon.
$E_t y_{y+1}$	Real GDP growth point forecasts of the investment bank's economists and Consensus Economics for the year ahead horizon.
$E_t \bar{y}_y$	One-year real GDP growth point forecasts horizon of the investment bank's economists and Consensus Economics.
ESI	The difference between the euro area Economic Sentiment Indicator (ESI) and its long-run average of 100 expressed in percentage points of the long-run average. The ESI is published by the European Commission on a monthly basis.

Table A.2: Summary statistics

DEPENDENT AND EXPLANATORY VARIABLES	Obs.	Mean	Std. deviation	Min	Max
ECB's main refinancing operations rate (refi rate) (%)	133	3.164	1.129	1.00	4.75
ECB's refi rate point forecast, investment bank (%)	133	3.160	1.135	1.00	4.75
Current quarter inflation, investment bank (%)	133	2.204	0.716	-0.50	4.00
Quarter ahead inflation, investment bank (%)	133	2.085	0.690	-0.40	4.00
One-quarter inflation, investment bank (%)	133	2.140	0.704	-0.27	3.98
Current year inflation, investment bank (%)	133	2.101	0.661	0.20	3.70
Year ahead inflation, investment bank (%)	133	1.807	0.358	1.00	2.60
One-year inflation, investment bank (%)	133	1.936	0.464	0.53	3.11
Current quarter real GDP growth, investment bank (%)	133	1.422	1.799	-5.20	4.20
Quarter ahead real GDP growth, investment bank (%)	133	1.538	1.725	-4.50	5.00
One-quarter real GDP growth, investment bank (%)	133	1.465	1.756	-4.61	4.33
Current year real GDP growth, investment bank (%)	133	1.497	1.719	-4.30	4.00
Year ahead real GDP growth, investment bank (%)	133	2.032	0.787	-0.50	3.60
One-year real GDP growth, investment bank (%)	133	1.700	1.219	-2.24	3.84
Current year inflation, consensus forecasts (%)	133	2.063	0.618	0.30	3.60
Year ahead inflation, consensus forecasts (%)	133	1.814	0.250	1.20	2.50
One-year inflation, consensus forecasts (%)	133	1.914	0.408	0.70	3.26
Current year real GDP growth, consensus forecasts (%)	133	1.548	1.627	-4.40	3.40
Year ahead real GDP growth, consensus forecasts (%)	133	2.030	0.765	-0.90	3.20
One-year real GDP growth, consensus forecasts (%)	133	1.777	1.116	-2.17	3.29
Economic Sentiment Indicator, deviation from long-run average (%)	133	0.968	10.413	-29.30	17.60

Note: The actual refi rate comes from the website of the ECB and the Economic Sentiment Indicator is taken from the European Commission's website. The long-run average of the ESI is equal to 100 as computed by the European Commission.

9.2 Unit root and stationarity tests

Table A.3: Unit root tests, Investment Bank Forecasts

Variables	ADF Z(t)	PP Z(t)	KPSS	Integration order
Refi rate	-2.031**	-0.630	0.607**	I(0)
	(0.022)	(0.864)		
Forecasted refi rate	-1.594*	-0.711	0.588**	I(0)
	(0.057)	(0.844)		
Expected inflation, current quarter	-2.989***	-1.962	0.184	I(0)
	(0.002)	(0.303)		
Expected inflation, quarter ahead	-3.758***	-2.740*	0.138	I(0)
	(0.000)	(0.067)		
Expected inflation, current year	-2.410***	-2.099	0.132	I(0)
	(0.009)	(0.245)		
Expected inflation, year ahead	-3.112***	-2.962**	0.138	I(0)
	(0.001)	(0.039)		
Expected inflation, one-quarter horizon	-4.486***	-2.089	0.154	I(0)
	(0.000)	(0.249)		
Expected inflation, one-year horizon	-4.278***	-2.481	0.121	I(0)
	(0.000)	(0.120)		
Expected GDP growth, current quarter	-1.950**	-1.507	0.515**	I(0)
	(0.027)	(0.530)		
Expected GDP growth, quarter ahead	-2.647***	-2.358	0.570**	I(0)
	(0.005)	(0.154)		
Expected GDP growth, current year	-0.254	0.040	0.577**	I(1)
	(0.400)	(0.962)		
Expected GDP growth, year ahead	-2.866***	-2.929**	0.777***	I(0)
	(0.002)	(0.042)		
Expected GDP growth, one-quarter horizon	-2.395***	-1.782	0.543**	I(0)
	(0.009)	(0.389)		
Expected GDP growth, one-year horizon	-2.664***	-2.097	0.640**	I(0)
	(0.004)	(0.246)		
ESI percentage deviation from the long-run average	-2.306**	-1.497	0.524**	I(0)
	(0.011)	(0.535)		
Observations	131	133	135	

Note: The ADF Z(t) and PP Z(t) refer to the Augmented Dickey-Fuller and Phillips-Perron tests for unit root in the variables. A statistically significant test shows evidence against the null hypothesis of unit root. For the ADF test 3 lags of the difference in the variables have been used, while the number of lags used in the Phillips-Perron test are determined automatically based on Newey-West bandwidth selection. The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test reports the statistic for testing the null hypothesis of level stationarity based on Newey-West automatic bandwidth selection. A statistically significant test shows evidence against the hypothesis of stationarity. The integration order is determined on the basis of the ADF, PP and KPSS test statistics. MacKinnon approximate p-values are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.4: Unit root tests, Consensus Economics Forecasts

Variables	ADF Z(t)	PP Z(t)	KPSS	Integration order
Expected inflation, current year	-2.910***	-2.168	0.0835	I(0)
	(0.002)	(0.218)		
Expected inflation, year ahead	-2.159**	-2.226	0.139	I(0)
	(0.016)	(0.197)		
Expected inflation, one-year horizon	-2.532***	-3.230**	0.073	I(0)
	(0.006)	(0.018)		
Expected GDP growth, current year	-0.719	0.541	0.614**	I(1)
	(0.237)	(0.986)		
Expected GDP growth, year ahead	-1.519*	-1.791	1.250***	I(1)
	(0.066)	(0.385)		
Expected GDP growth, one-year horizon	-2.755***	-1.686	0.834***	I(1)
	(0.003)	(0.438)		
Observations	131	133	135	

Note: The ADF Z(t) and PP Z(t) refer to the Augmented Dickey-Fuller and Phillips-Perron tests for unit root in the variables. A statistically significant test shows evidence against the null hypothesis of unit root. For the ADF test 3 lags of the difference in the variables have been used, while the number of lags used in the Phillips-Perron test are determined automatically based on Newey-West bandwidth selection. The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test reports the statistic for testing the null hypothesis of level stationarity based on Newey-West automatic bandwidth selection. A statistically significant test shows evidence against the hypothesis of stationarity. The integration order is determined on the basis of the ADF, PP and KPSS test statistics. MacKinnon approximate p-values are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

9.3 Actual and Perceived Taylor Rules with a dummy variable for the ECB meetings

Table A.5: Actual Taylor Rule, 2000-2009 meeting dummy

	Quarter ahead	Year ahead	One-quarter horizon	One-year horizon
ρ	0.8734***	0.9152***	0.7609***	0.8217***
	(0.0326)	(0.0203)	(0.0535)	(0.0517)
β_π	0.5503***	1.7607***	0.5569***	1.0949***
	(0.1183)	(0.2528)	(0.0792)	(0.1448)
β_y	0.4315***	1.2135***	0.2743***	0.3942***
	(0.1247)	(0.3101)	(0.0582)	(0.1478)
Meeting	0.0103***	0.0069**	0.0120***	0.0113***
	(0.0017)	(0.0028)	(0.0011)	(0.0014)
α	0.0094***	-0.0290***	0.0118***	-0.0002
	(0.0014)	(0.0078)	(0.0016)	(0.0019)
R^2	0.9816	0.9835	0.9738	0.9804
Observations	133	133	133	133
Hansen J-statistic	1.5172	1.4370	1.3877	1.3611
ADF Z(t)	-4.621***	-4.342***	-3.291**	-3.882***
PP Z(t)	-9.109***	-10.524***	-6.680***	-8.585***

Note: GMM estimates, HAC standard errors are computed with the Delta method and are denoted in parentheses. The table reports the long-run response coefficients. The regressions are performed for all forecast horizons. The variable "Meeting" is a dummy that takes the value of 1 when the Governing Council of the ECB has met more than once within a month until November 2001. The Hansen J-statistic tests whether the over-identifying restrictions are satisfied. A statistically significant test shows evidence against the validity of the instruments. The ADF Z(t) and PP Z(t) refer to the Augmented Dickey-Fuller and Phillips-Perron statistics respectively. Both are used to determine whether the residuals contain a unit root. A statistically significant test shows evidence against the null hypothesis of unit root. For the ADF test 3 lags of the difference in the residuals have been used, while the number of lags used in the Phillips-Perron test are determined automatically based on Newey-West bandwidth selection. *** p<0.01, ** p<0.05, * p<0.1.

Table A.6: Perceived Taylor Rule, 2000-2009 meeting dummy

	Quarter ahead	Year ahead	One-quarter horizon	One-year horizon
ρ	0.8818***	0.9046***	0.7627***	0.8398***
	(0.0119)	(0.0249)	(0.0263)	(0.0218)
β_π	0.6525***	2.2412***	0.6300***	1.3334***
	(0.0973)	(0.2803)	(0.0690)	(0.0988)
β_y	0.4283***	0.9098***	0.2618***	0.3734***
	(0.0783)	(0.2434)	(0.0440)	(0.1092)
Meeting	0.0095***	0.0087***	0.0114***	0.0109***
	(0.0017)	(0.0023)	(0.0011)	(0.0014)
α	0.0072***	-0.0320***	0.0107***	-0.0046**
	(0.0015)	(0.0087)	(0.0014)	(0.0021)
R^2	0.9808	0.9833	0.9725	0.9806
Observations	133	133	133	133
Hansen J-statistic	1.7722	1.5055	1.4961	1.4681
ADF Z(t)	-4.087***	-4.127***	-2.787*	-3.516***
PP Z(t)	-9.978***	-10.457***	-7.180***	-9.527***

Note: GMM estimates, HAC standard errors are computed with the Delta method and are denoted in parentheses. The table reports the long-run response coefficients. The regressions are performed for all forecast horizons. The variable "Meeting" is a dummy that takes the value of 1 when the Governing Council of the ECB has met more than once within a month until November 2001. The Hansen J-statistic tests whether the over-identifying restrictions are satisfied. A statistically significant test shows evidence against the validity of the instruments. The ADF Z(t) and PP Z(t) refer to the Augmented Dickey-Fuller and Phillips-Perron statistics respectively. Both are used to determine whether the residuals contain a unit root. A statistically significant test shows evidence against the null hypothesis of unit root. For the ADF test 3 lags of the difference in the residuals have been used, while the number of lags used in the Phillips-Perron test are determined automatically based on Newey-West bandwidth selection. *** p<0.01, ** p<0.05, * p<0.1.

9.4 Actual and Perceived Taylor Rules with Consensus Economics Forecasts

Table A.7: Actual Taylor Rule, 2000-2009 consensus forecasts

	Year ahead	One-year horizon
ρ	0.8928***	0.8923***
	(0.0194)	(0.0173)
β_π	2.1397***	-0.1349
	(0.3255)	(0.2434)
β_y	1.5716***	1.1680***
	(0.1740)	(0.1300)
α	-0.0410***	0.0119**
	(0.0083)	(0.0052)
R^2	0.9833	0.9806
Observations	133	133
Hansen J-statistic	1.1341	1.6593
ADF Z(t)	-4.162***	-4.310***
PP Z(t)	-10.445***	-9.618***

Note: GMM estimates, HAC standard errors are computed with the Delta method and are denoted in parentheses. The table reports the long-run response coefficients. The regressions are performed for the specifications with the forecasts for the year ahead and the one-year horizon respectively. The Hansen J-statistic tests whether the over-identifying restrictions are satisfied. A statistically significant test shows evidence against the validity of the instruments. The ADF Z(t) and PP Z(t) refer to the Augmented Dickey-Fuller and Phillips-Perron statistics respectively. Both are used to determine whether the residuals contain a unit root. A statistically significant test shows evidence against the null hypothesis of unit root. For the ADF test 3 lags of the difference in the residuals have been used, while the number of lags used in the Phillips-Perron test are determined automatically based on Newey-West bandwidth selection. *** p<0.01, ** p<0.05, * p<0.1.

Table A.8: Perceived Taylor Rule, 2000-2009 consensus forecasts

	Year ahead	One-year horizon
ρ	0.9322***	0.8557***
	(0.0129)	(0.0242)
β_π	2.7004***	0.7590***
	(0.4857)	(0.1372)
β_y	1.7088***	0.8845***
	(0.3124)	(0.1286)
α	-0.0556***	-0.0001
	(0.0105)	(0.0043)
R^2	0.9809	0.9779
Observations	133	133
Hansen J-statistic	1.0823	1.6747
ADF Z(t)	-4.009***	-3.128**
PP Z(t)	-10.899***	-9.150***

Note: GMM estimates, HAC standard errors are computed with the Delta method and are denoted in parentheses. The table reports the long-run response coefficients. The regressions are performed for the specifications with the forecasts for the year ahead and the one-year horizon respectively. The Hansen J-statistic tests whether the over-identifying restrictions are satisfied. A statistically significant test shows evidence against the validity of the instruments. The ADF Z(t) and PP Z(t) refer to the Augmented Dickey-Fuller and Phillips-Perron statistics respectively. Both are used to determine whether the residuals contain a unit root. A statistically significant test shows evidence against the null hypothesis of unit root. For the ADF test 3 lags of the difference in the residuals have been used, while the number of lags used in the Phillips-Perron test are determined automatically based on Newey-West bandwidth selection. *** p<0.01, ** p<0.05, * p<0.1.

9.5 Actual and Perceived Taylor Rules with the Economic Sentiment Indicator

Table A.9: Actual Taylor Rule, 2000-2009 ESI

	Quarter ahead	Year ahead	One-quarter horizon	One-year horizon
ρ	0.8735***	0.8943***	0.8624***	0.8857***
	(0.0126)	(0.0110)	(0.0142)	(0.0177)
β_π	0.3254***	0.1467	0.3092***	0.4559**
	(0.0918)	(0.1978)	(0.0902)	(0.1797)
β_{esi}	0.1157***	0.1359***	0.1120***	0.1223***
	(0.0099)	(0.0108)	(0.0093)	(0.0169)
α	0.0225***	0.0262***	0.0230***	0.0203***
	(0.0021)	(0.0037)	(0.0020)	(0.0034)
R^2	0.9842	0.9847	0.9835	0.9846
Observations	133	133	133	133
Hansen J-statistic	1.5691	1.2861	1.4809	1.2772
ADF Z(t)	-4.624***	-5.044***	-4.306***	-4.953***
PP Z(t)	-10.371***	-10.833***	-10.060***	-10.753***

Note: GMM estimates, HAC standard errors are computed with the Delta method and are denoted in parentheses. The table reports the long-run response coefficients. The regressions are performed for the specifications with the forecasts for the quarter ahead and the year ahead respectively. The Hansen J-statistic tests whether the over-identifying restrictions are satisfied. A statistically significant test shows evidence against the validity of the instruments. The ADF Z(t) and PP Z(t) refer to the Augmented Dickey-Fuller and Phillips-Perron statistics respectively. Both are used to determine whether the residuals contain a unit root. A statistically significant test shows evidence against the null hypothesis of unit root. For the ADF test 3 lags of the difference in the residuals have been used, while the number of lags used in the Phillips-Perron test are determined automatically based on Newey-West bandwidth selection. *** p<0.01, ** p<0.05, * p<0.1.

Table A.10: Perceived Taylor Rule, 2000-2009 ESI

	Quarter ahead	Year ahead	One-quarter horizon	One-year horizon
ρ	0.9267***	0.9287***	0.9182***	0.9222***
	(0.0094)	(0.0084)	(0.0115)	(0.0094)
β_π	0.3814***	1.3603***	0.3373**	0.9780***
	(0.1386)	(0.3204)	(0.1384)	(0.2036)
β_{esi}	0.1470***	0.1356***	0.1392***	0.1288***
	(0.0147)	(0.0136)	(0.0151)	(0.0134)
α	0.0192***	0.0024	0.0205***	0.0085*
	(0.0031)	(0.0062)	(0.0029)	(0.0044)
R^2	0.9839	0.9844	0.9837	0.9842
Observations	133	133	133	133
Hansen J-statistic	1.7572	1.5648	1.7001	1.5928
ADF Z(t)	-5.112***	-5.276***	-4.905***	-5.138***
PP Z(t)	-12.330***	-12.540***	-12.118***	-12.423***

Note: GMM estimates, HAC standard errors are computed with the Delta method and are denoted in parentheses. The table reports the long-run response coefficients. The regressions are performed for the specifications with the forecasts for the quarter ahead and the year ahead respectively. The Hansen J-statistic tests whether the over-identifying restrictions are satisfied. A statistically significant test shows evidence against the validity of the instruments. The ADF Z(t) and PP Z(t) refer to the Augmented Dickey-Fuller and Phillips-Perron statistics respectively. Both are used to determine whether the residuals contain a unit root. A statistically significant test shows evidence against the null hypothesis of unit root. For the ADF test 3 lags of the difference in the residuals have been used, while the number of lags used in the Phillips-Perron test are determined automatically based on Newey-West bandwidth selection. *** p<0.01, ** p<0.05, * p<0.1.

9.6 Actual and Perceived Taylor Rules with Consensus inflation forecasts and the Economic Sentiment Indicator

Table A.11: Actual Taylor Rule, 2000-2009 consensus forecasts and ESI

	Year ahead	One-year horizon
ρ	0.8796***	0.8805***
	(0.0117)	(0.0231)
β_π	0.6212***	0.2869**
	(0.2171)	(0.1348)
β_{esi}	0.1243***	0.1295***
	(0.0093)	(0.0181)
α	0.0178***	0.0233***
	(0.0042)	(0.0022)
R^2	0.9843	0.9841
Observations	133	133
Hansen J-statistic	1.4254	1.3470
ADF Z(t)	-4.779***	-4.862***
PP Z(t)	-10.552***	-10.513***

Note: GMM estimates, HAC standard errors are computed with the Delta method and are denoted in parentheses. The table reports the long-run response coefficients. The regressions are performed for the specifications with the forecasts for the year ahead and the one-year horizon respectively. The Hansen J-statistic tests whether the over-identifying restrictions are satisfied. A statistically significant test shows evidence against the validity of the instruments. The ADF Z(t) and PP Z(t) refer to the Augmented Dickey-Fuller and Phillips-Perron statistics respectively. Both are used to determine whether the residuals contain a unit root. A statistically significant test shows evidence against the null hypothesis of unit root. For the ADF test 3 lags of the difference in the residuals have been used, while the number of lags used in the Phillips-Perron test are determined automatically based on Newey-West bandwidth selection. *** p<0.01, ** p<0.05, * p<0.1.

Table A.12: Perceived Taylor Rule, 2000-2009 consensus forecasts and ESI

	Year ahead	One-year horizon
ρ	0.9263***	0.8745***
	(0.0087)	(0.0197)
β_π	0.7741*	0.9538***
	(0.4045)	(0.1078)
β_{esi}	0.1559***	0.1108***
	(0.0145)	(0.0156)
α	0.0131*	0.0106***
	(0.0075)	(0.0026)
R^2	0.9838	0.9829
Observations	133	133
Hansen J-statistic	1.3553	1.6493
ADF Z(t)	-5.234***	-3.998**
PP Z(t)	-12.399***	-11.046***

Note: GMM estimates, HAC standard errors are computed with the Delta method and are denoted in parentheses. The table reports the long-run response coefficients. The regressions are performed for the specifications with the forecasts for the year ahead and the one-year horizon respectively. The Hansen J-statistic tests whether the over-identifying restrictions are satisfied. A statistically significant test shows evidence against the validity of the instruments. The ADF Z(t) and PP Z(t) refer to the Augmented Dickey-Fuller and Phillips-Perron statistics respectively. Both are used to determine whether the residuals contain a unit root. A statistically significant test shows evidence against the null hypothesis of unit root. For the ADF test 3 lags of the difference in the residuals have been used, while the number of lags used in the Phillips-Perron test are determined automatically based on Newey-West bandwidth selection. *** p<0.01, ** p<0.05, * p<0.1.

9.7 Predicted refi rate target, Investment Bank Forecasts

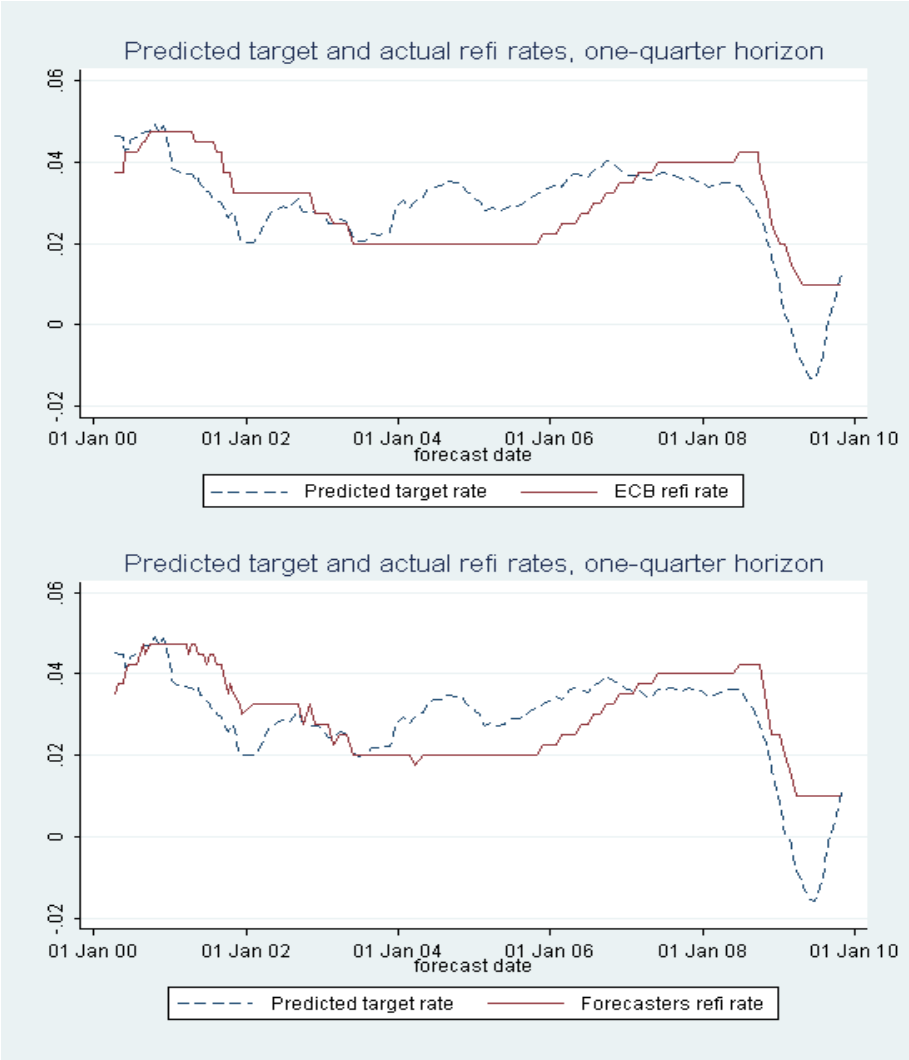

Figure A.1: Actual and Perceived Taylor Rules, one-quarter forecasts

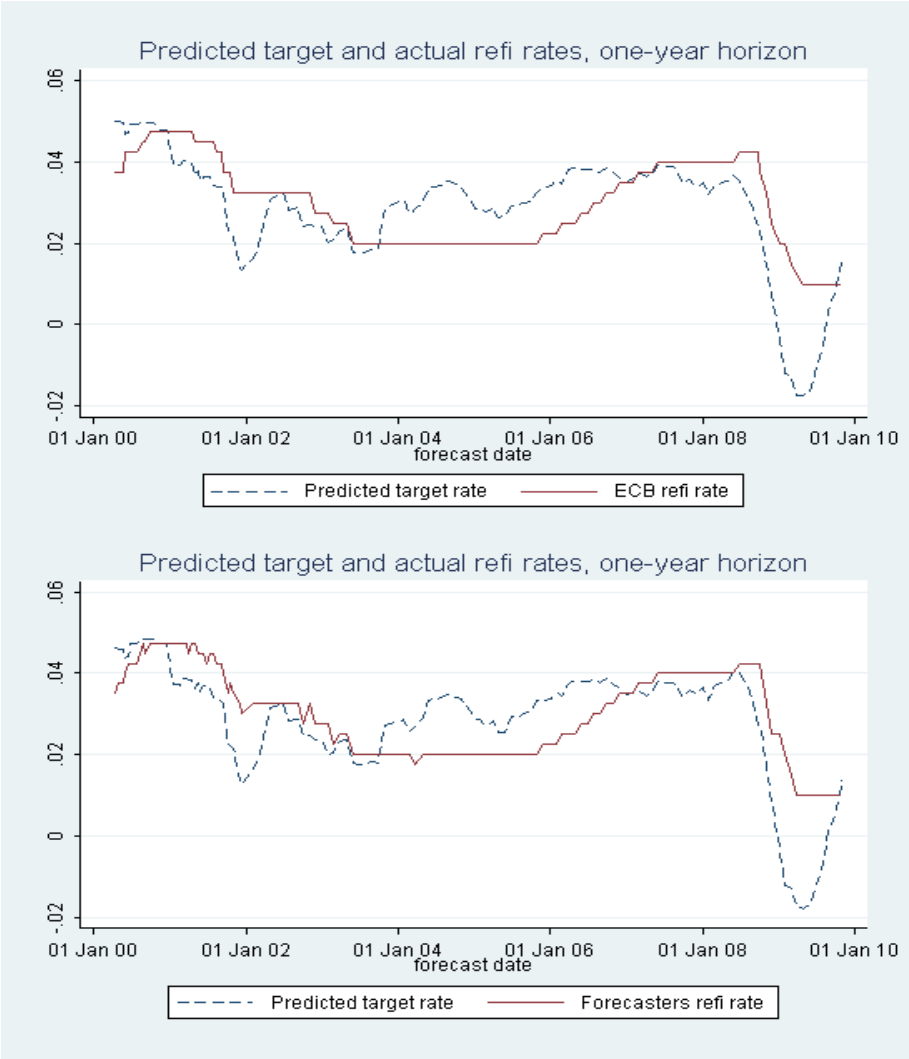

Figure A.2: Actual and Perceived Taylor Rules, one-year forecasts

9.8 Predicted refi rate target, Consensus Economics Forecasts

Figure A.3: Actual and Perceived Taylor Rules, year ahead consensus forecasts

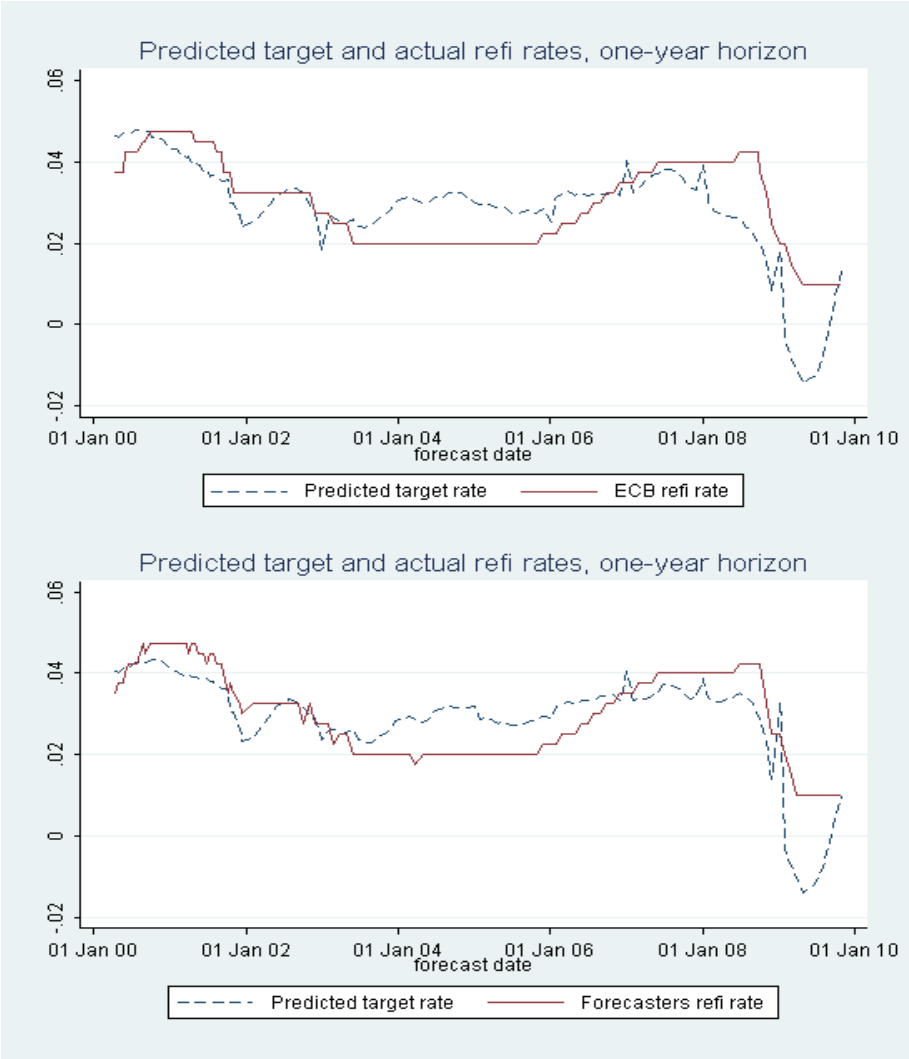

Figure A.4: Actual and Perceived Taylor Rules, one-year consensus forecasts

9.9 Rolling window estimates, one-year horizon

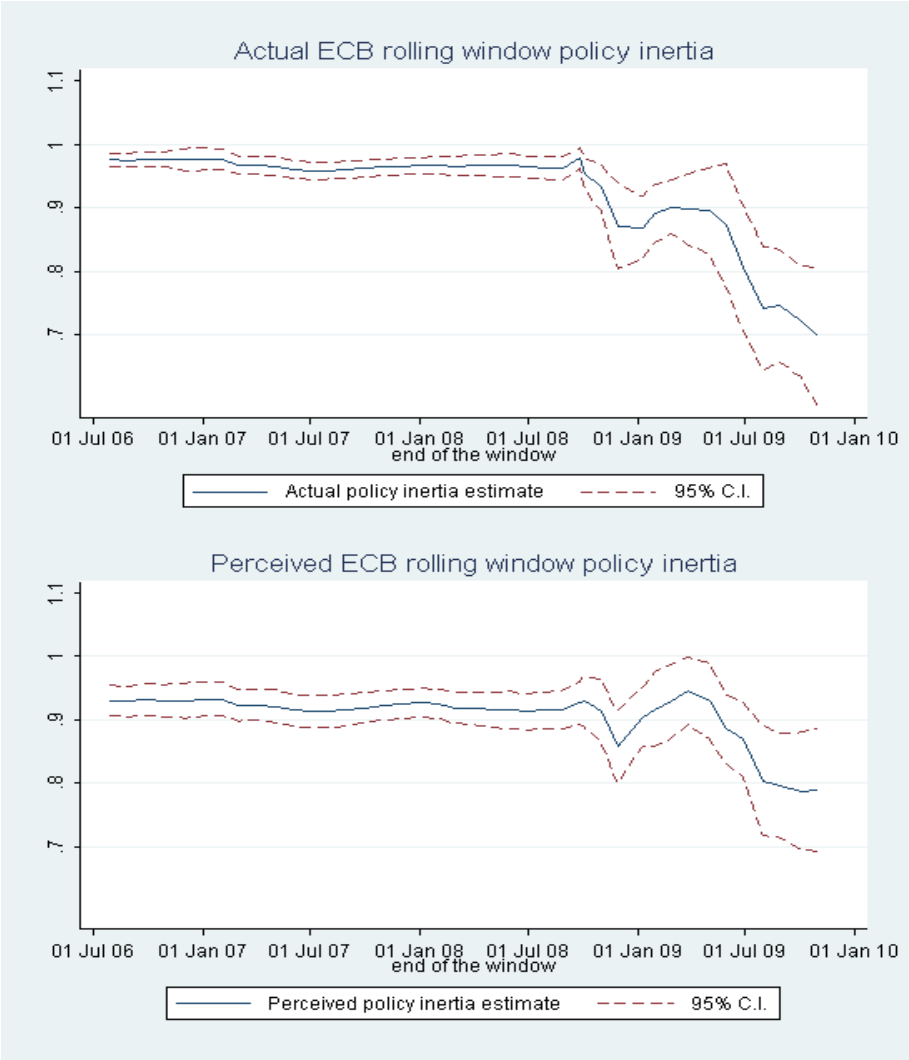

Figure A.5: Policy inertia estimates, one-year forecasts (rolling)

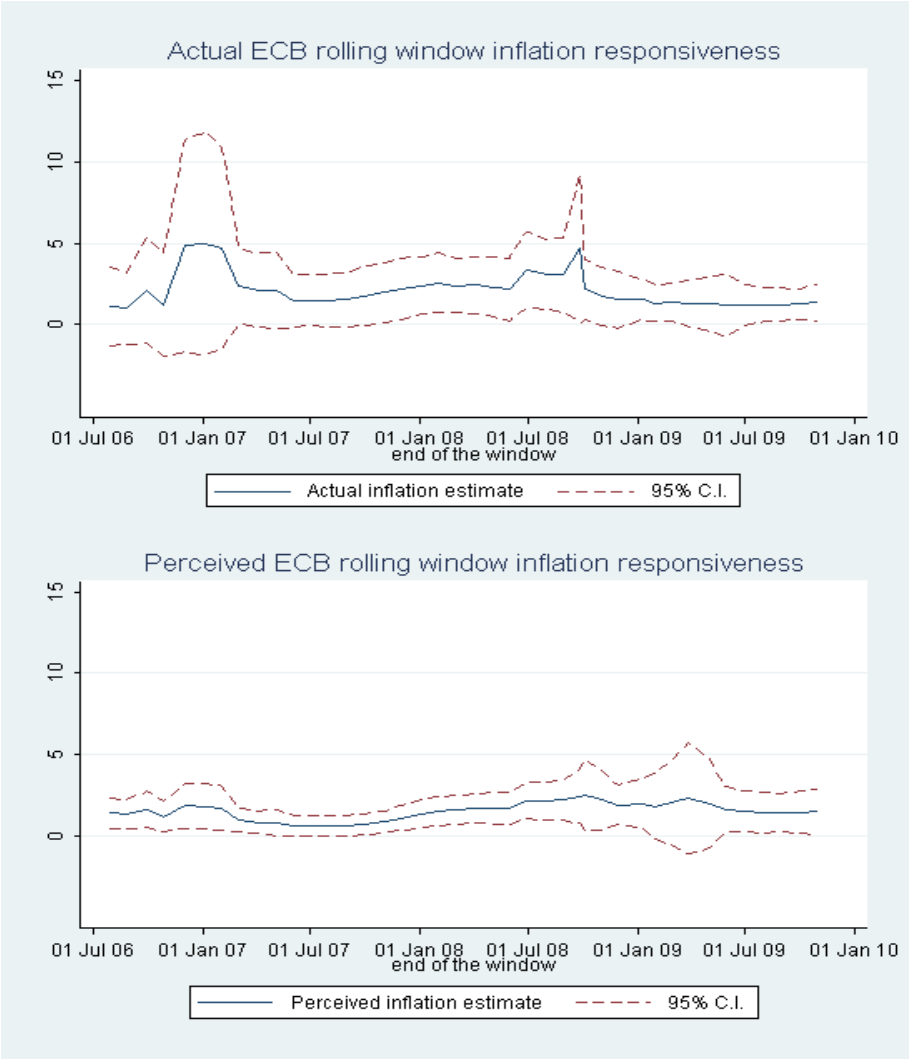

Figure A.6: Inflation coefficient estimates, one-year forecasts (rolling)

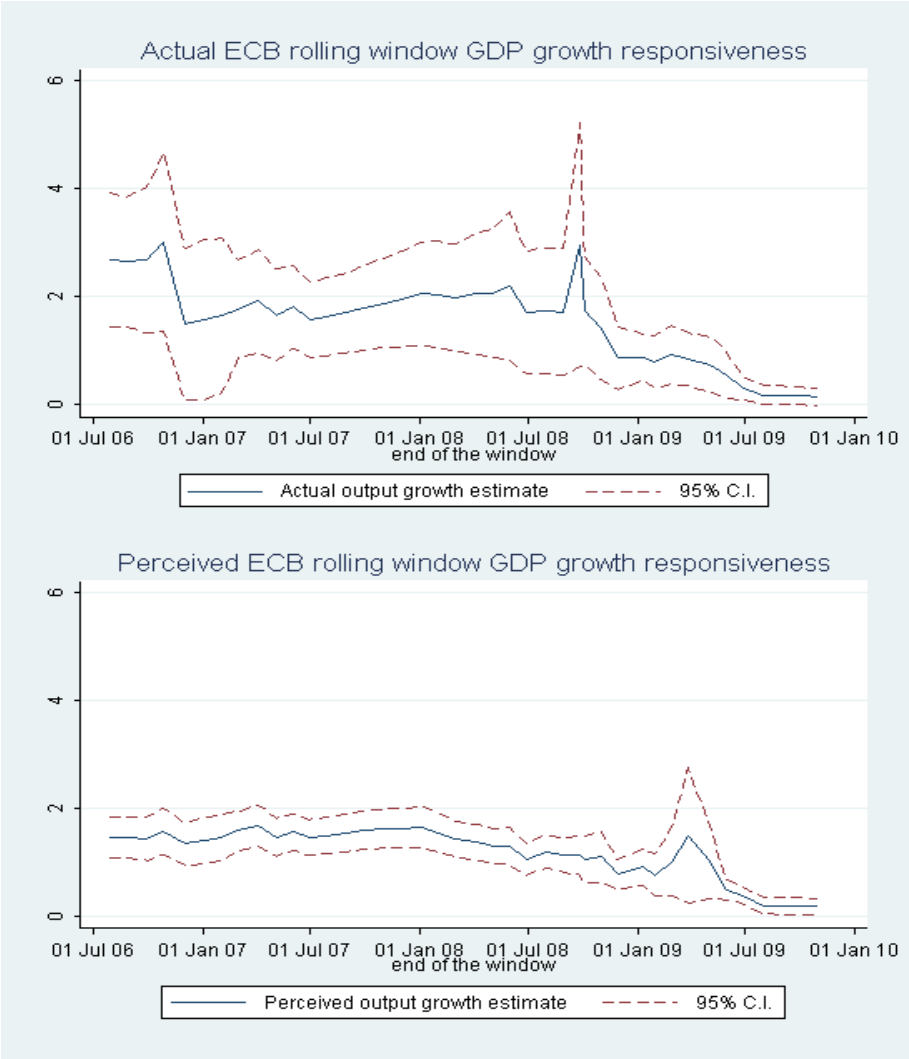

Figure A.7: Output growth coefficient estimates, one-year forecasts (rolling)

9.10 Recursive window estimates, year ahead horizon

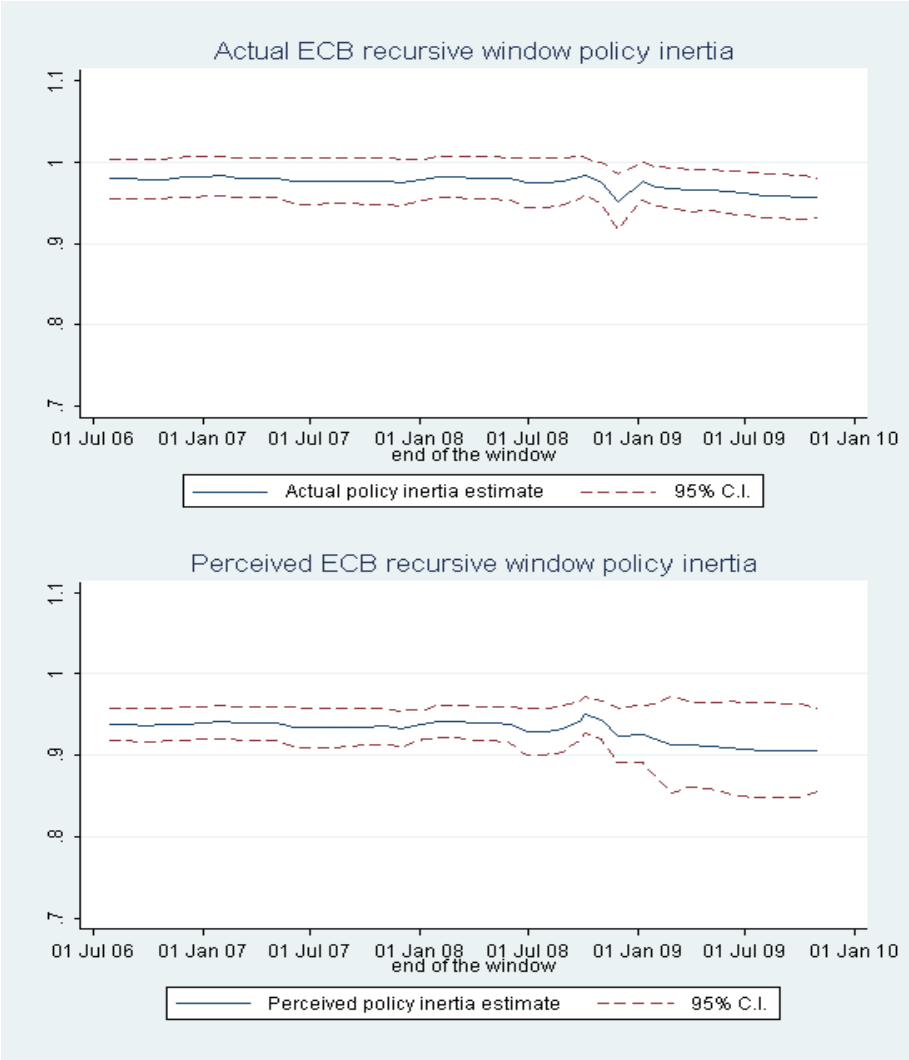

Figure A.8: Policy inertia estimates, year ahead forecasts (recursive)

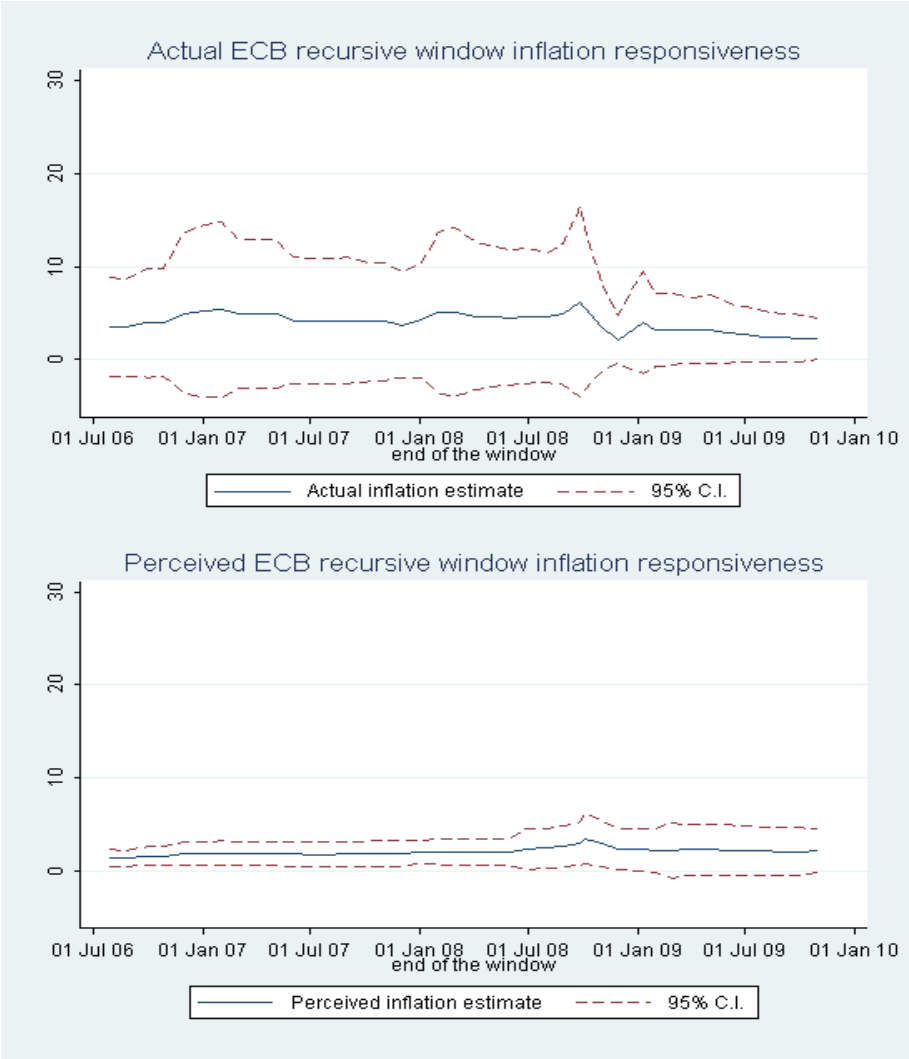

Figure A.9: Inflation coefficient estimates, year ahead forecasts (recursive)

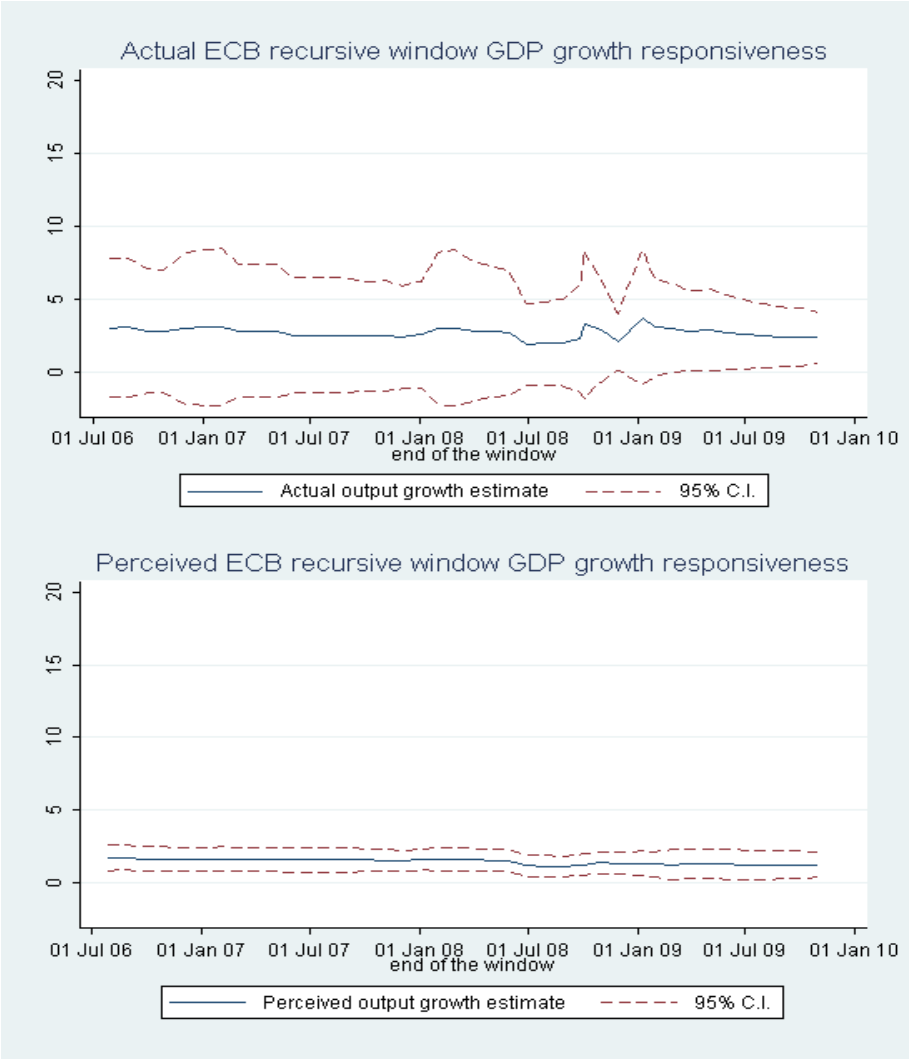

Figure A.10: Output growth coefficient estimates, year ahead forecasts (recursive)

9.11 Recursive window estimates, one-year horizon

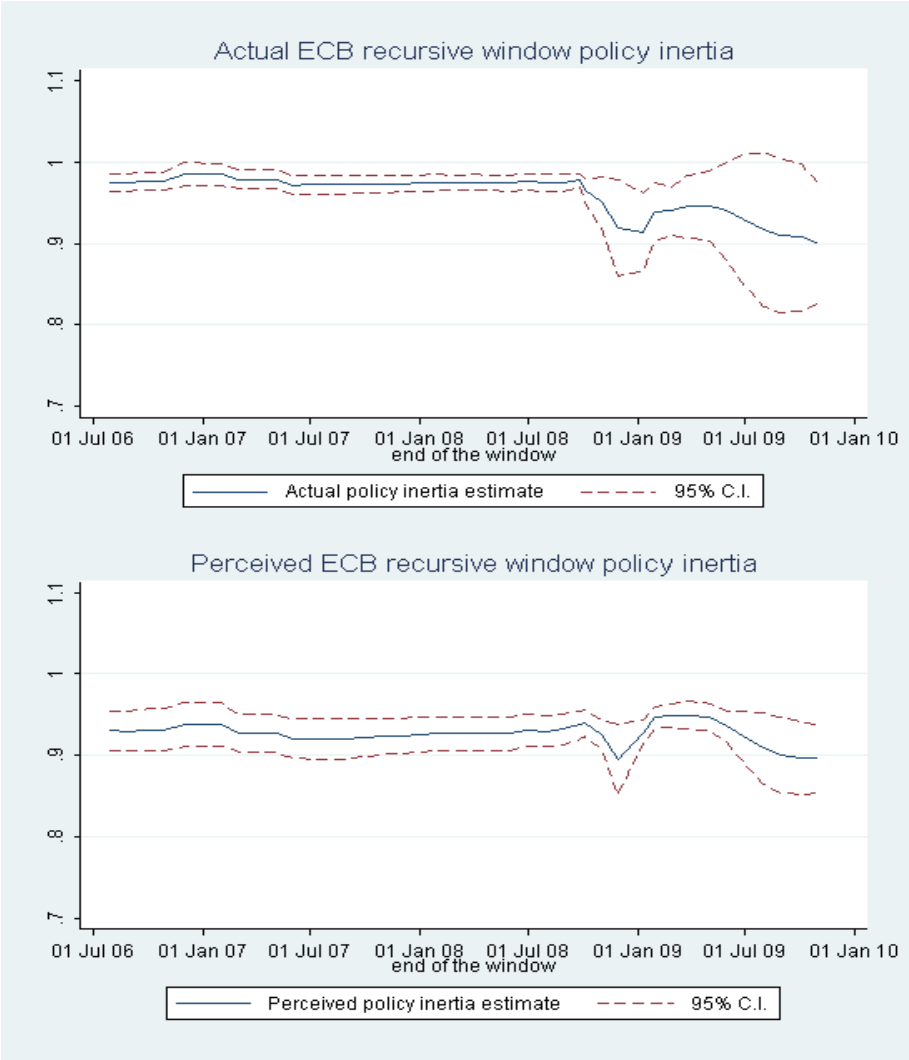

Figure A.11: Policy inertia estimates, one-year forecasts (recursive)

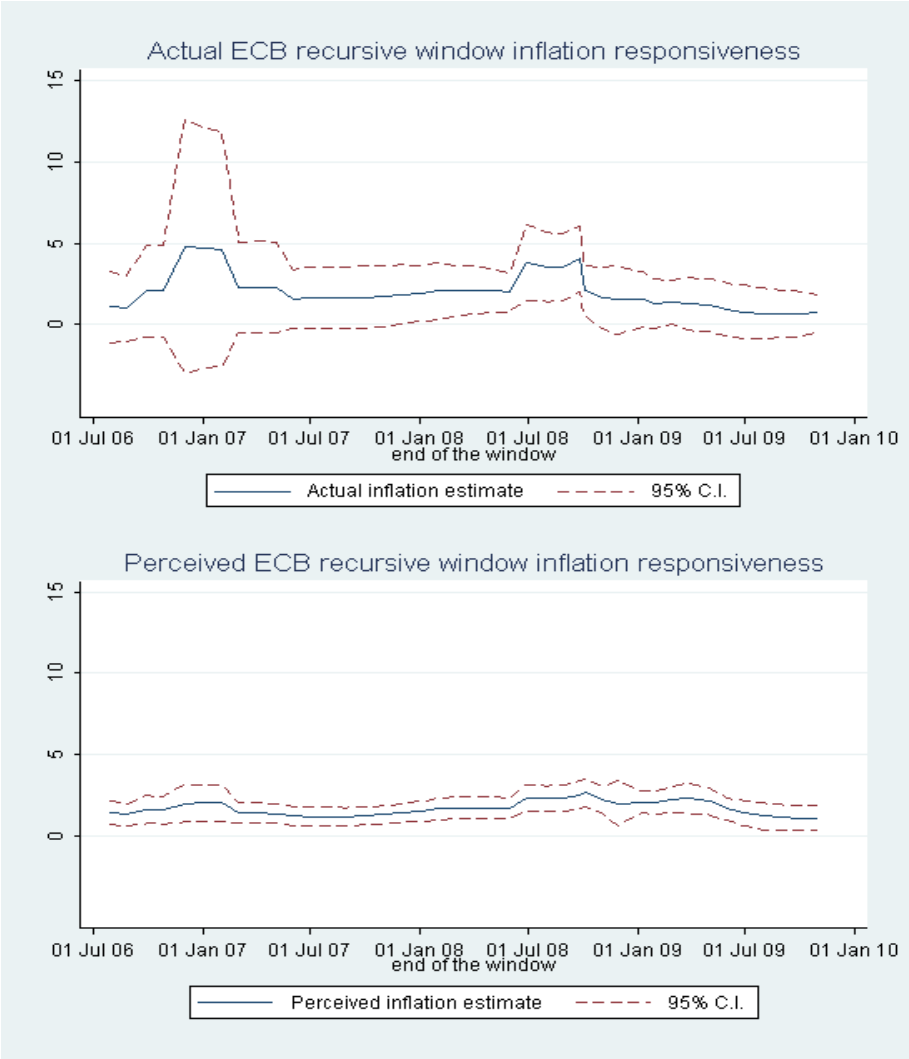

Figure A.12: Inflation coefficient estimates, one-year forecasts (recursive)

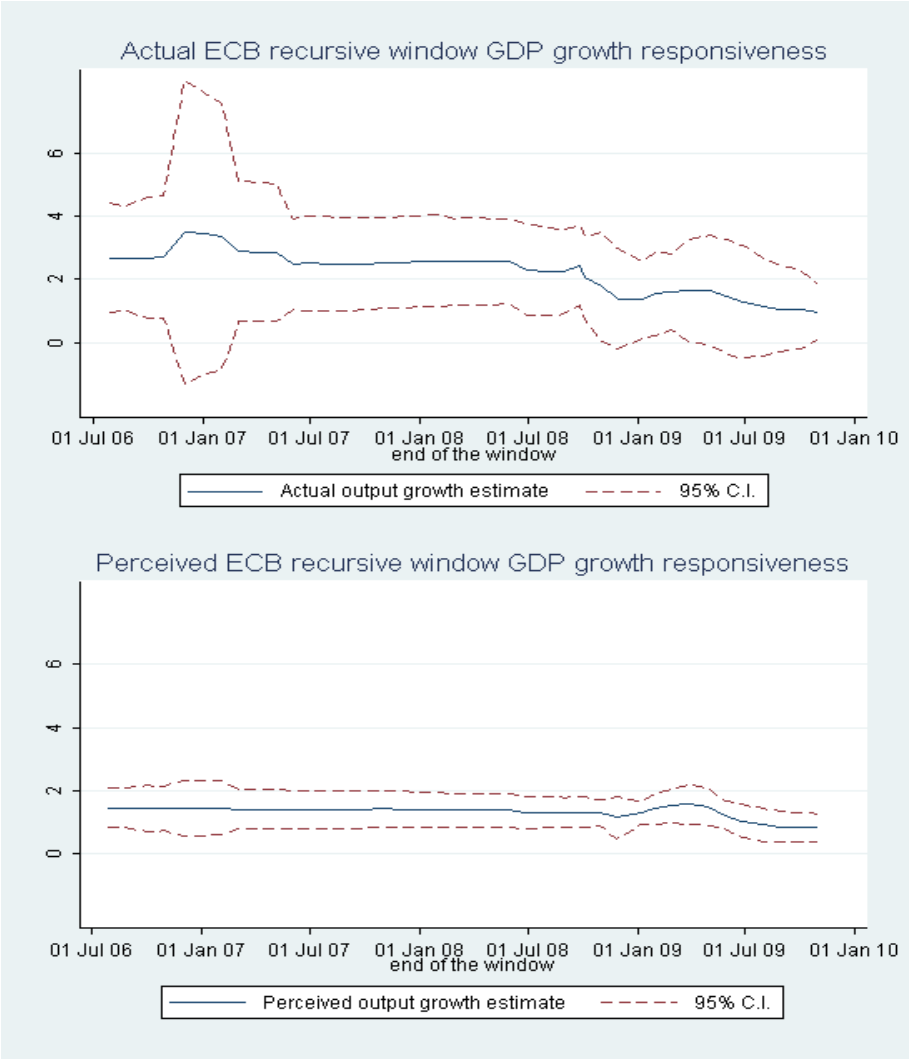

Figure A.13: Output growth coefficient estimates, one-year forecasts (recursive)