The British opt-out from the European Monetary Union: empirical evidence from monetary policy rules

Stefano d'Addona*   Ilaria Musumeci†

*Department of International Studies, University of Rome 3, Via G. Chiabrera, 199, I-00145 Rome; +39-06-5733-5331; daddona@uniroma3.it and Baruch College CUNY, One Bernard Baruch Way, 10010 New York.

†University of Rome 3

The British opt-out from the European Monetary Union: empirical evidence from monetary policy rules

Keywords: Taylor rule; European monetary integration; Regime switching models; Interest rate smoothing.
JEL: E32, E52, E38

Abstract

We analyze the current state of the monetary integration in Europe focusing on the UK position regarding the European Monetary Union. The interest rates decisions of the European Central Bank and the Bank of England are compared through different specifications of the Taylor Rule. The comparison of the monetary conducts provides a useful feedback when looking for the differences claimed by the British government as motivating the UK refusal to join the European Monetary Union. Testing for a forward looking behavior and possible asymmetries in the policy responses, we show evidence supporting the opt-out by the UK monetary authorities.

1 Introduction

The British opt-out is key in shaping the monetary policy interaction between United Kingdom and the European Union. It is well known that the Bank of England (BoE) and the European Central Bank (ECB) are historically committed to somehow different priorities: the Monetary Policy Committee of the BoE supports the objectives of growth and employment while maintaining price stability, on the contrary, for the ECB, price stability is the priority. Moreover, it is often argued by British monetary authorities that the European Central Bank conservative approach to monetary policy and its overriding commitment to price stability, might be destabilizing for British economy both in stationary conditions and under economic cyclical fluctuations.

We compare the ECB and BoE monetary policies to check for the lack of monetary convergence claimed by the British government as motivating the refusal to join the monetary union. In doing that, we use a Taylor Rule approach.

Introduced by Taylor (1993), the "Rule" is proposed as a monetary policy conduct: interest rates are systematically set in response to the upward or downward deviations of the inflation rate and the output from its target and its potential level respectively. Starting from this, a vast empirical literature followed (for a comprehensive review see Sauer and Sturm, 2003) and several theoretical modifications were proposed. In particular Clarida et al. (1998) introduce expectations in the model, while Sack and Wieland (2000) discuss the role of interest rate smoothing.

The empirical literature on this field covers both the Bank of England

and the ECB monetary policy actions. A comprehensive study about the Bank of England monetary choices has been presented by Nelson (2000) who estimates the Taylor Rule for different subsamples based on relevant monetary changes between 1972 and 1997. The author finds that the response to the inflation and to the output gap varies within the chosen subsamples, showing that the *policy* priorities changed over time. In particular he argues that the commitment to price stability was not significant between 1987 and 1990 and it became relevant after 1992. McCallum (2000) compares the classical Taylor rule with an alternative policy where the monetary base is targeted by the BoE. His estimation shows that while both rules are able to catch the inflationary pressures of the 1970s, the monetary base instrument rule implies that policy was too loose during the middle and late 80s whereas the Taylor rules does not.

As soon as the ECB officially entered into operation in 1998, many studies proposed an *ex-ante* approach to the future policy conduct in the Euro area and compared it to monetary policy rules. By simulating an open economy model, Taylor (1999) argues that a simple benchmark rule as the Taylor Rule is a good candidate in terms of efficiency and robustness as a guideline for ECB monetary policy. In a similar setup, Peersman and Smets (1999) compare several monetary rules simulating a closed economy model based on five European Countries[1]. The authors show that the original Taylor Rule does a good job in stabilizing inflation and output without any need for other instrument variables in the model. In an empirical contribution, Gerlach and Schnabel (2000) test the Taylor Rule using a proxy of the EU

[1]The selected countries are Austria, Belgium, France, Germany, and the Netherlands.

monetary conduct by weighting economic data of eleven countries between 1990 and 1997. They find that the original Taylor Rule performs well with estimates of the coefficients close to those of Taylor (1993). They also test a forward looking specification augmented with several economic variables as controls, showing similar results. As a first test of the Taylor rule based on EU data Sauer and Sturm (2003) compare the monetary conducts of the ECB and the Bundesbank. Testing both a classical Taylor rule and a forward looking one, they argue that The European Central Bank inherited the *conservative* approach from the Bundesbank.

Building on this literature, we test the Taylor Rule for both the ECB and the BoE in its basic form and the relevant extensions. The robustness of results is checked introducing both forward looking expectations (see Clarida et al., 1998) and the interest rate smoothing (see Sack and Wieland, 2000) in our estimation. Following Gerlach and Schnabel (2000), further instrument variables to control for the role of the exchange rate and the monetary markets are introduced.

Finally, we complete our analysis testing for Central Banks' behavior under different phases of the business cycle. In its basic formulation, the Taylor Rule implies a symmetric behavior by the Central Banks while setting the interest rates. This implicit hypothesis was recently challenged in the literature both empirically and theoretically. On the empirical side, there are recent contributions showing evidence of non linearities for three European countries (Germany, France and Spain) and the US monetary policies (see Dolado et al., 2004, 2005). On the theoretical side, non linearities in the policy responses are explained with: i) non linearities in the underlying aggregate supply schedule (see Nobay and Peel, 2000), ii) non linear preferences for the policy makers (e.g. Surico, 2007), iii) uncertainty in economic fundamentals (see Meyer et al., 2001).

To test for a possible non linear behavior by the policy makers, we take regime-switching into the model assuming that the output switches among different and unobservable states of the economy. Central bankers infer regime probabilities from output realizations, so that they develop their state beliefs and use them to formulate asymmetric monetary policy decisions[2]. This exercise improves our work since it accounts for possible shifts in the monetary policies due to economic downturn that affected both the economic systems over the sample period we analyze. Furthermore it allows us to check if the ECB and BoE's attitudes to achieve output stabilization is not aligned when changing economic conditions are taken into account.

The remainder of the paper is organized as follows: section 2 introduces the theoretical framework behind the monetary rules. In section 3 we describe the data and explain the details of our empirical strategy. Section 4 presents the results and section 5 concludes. concludes.

2 Methodology

The baseline monetary policy reaction function used in our empirical exercise is a classical Taylor rule specified as:

[2]With a quite different approach, Altavilla and Landolfo (2005) compared ECB and BoE's monetary policies through a Markov-Switching Vector Autoregressive (MS-VAR) model to detect possible asymmetries in front of economic fluctuations.

$$i_t = i^* + \beta(\pi_t - \pi^*) + \gamma(y_t - y^*), \tag{1}$$

where i^* is the steady state value of the nominal interest rate, π_t is the current inflation rate, π^* is the inflation target set by the central bank, y_t is the real output of the economy and y^* is its potential level.

We estimate its empirical counterpart as

$$i_t = \alpha + \beta\pi_t + \gamma g_t + \upsilon_t \tag{2}$$

where $\alpha = i^* - \beta\pi^*$ defines the real interest rate, $g_t = (y_t - y^*)$ is the output gap, and υ_t is an i.i.d normal error term.

As a second step in our empirical analysis we investigate whether central bankers respond to anticipated inflation rather then realized inflation. To do this, we can follow Clarida et al. (1998) in specifying the monetary policy reaction function as

$$\widehat{i_t} = i^* + \beta(\mathrm{E}_t\left[\pi_{t+n}\right] - \pi^*) + \gamma(y_t - y^*) \tag{3}$$

where the actual rate partially adjust to the specified target $(\widehat{i_t})$ to account for a smoothing behavior by central bankers (see Goodfriend (1991) and Sack and Wieland (2000), among others):

$$i_t = (1-\rho)\widehat{i_t} + \rho i_{t-1} + \varpi_t \tag{4}$$

with i_{t-1} being the lagged interest rate, ρ being the coefficient capturing the degree of smoothing of the interest rate, and ϖ_t being a standard i.i.d. error term. By combining equation (3) and (4), we obtain the estimable equation

$$i_t = \alpha^* + \beta^* \, \mathrm{E}_t \left[\pi_{t+n}\right] + \gamma^* g_t + \rho i_{t-1} + \varpi_t, \tag{5}$$

where $\alpha^* = \alpha(1-\rho)$, $\beta^* = \beta(1-\rho)$, and $\gamma^* = \gamma(1-\rho)$.

2.1 Regime switching model

To investigate whether central bankers respond asymmetrically to business cycle, we model the above introduced monetary reaction functions (eqs. (2) and (5)) in a regime switching economy. We model an economy where the output switches between (unobservable) states, and an agent (i.e. a central banker) infers the probabilities of being in a particular state from the output realizations. The inferred probabilities are then used in the monetary policy decisions[3].

Specifically, We consider the economy in a regime switching model, where its latent state is indicated by s_t. We assume that s_t follows a hidden Markov chain with transition probabilities matrix P (see Hamilton (1989)).

The two reaction functions (2) and (5) are then specified as regime dependent policy rules:

$$i_t = \alpha(s_t) + \beta(s_t)\pi_t + \gamma(s_t)g_t + \upsilon_t \tag{6}$$

$$i_t = \alpha^*(s_t) + \beta^*(s_t) \, \mathrm{E}_t \left[\pi_{t+n}\right] + \gamma^*(s_t)g_t + \rho^*(s_t)i_{t-1} + \varpi_t \tag{7}$$

[3]Instead, in their MS-VAR setting, Altavilla and Landolfo (2005) specify the reaction functions as regime dependent

The evolution of the state of the economy in terms of state beliefs (ξ_{t+1}) can be expressed as realizations of the equation:

$$\xi_{t+1} = P\xi_t + \epsilon_t. \tag{8}$$

The agents cannot directly observe the state of the economy, s_t, and they have to rely on interpreting external signals. In our specification we use as a signal of the state of the economy the output growth rates ($\Delta \log y_t$), which is supposed to follow a state dependent process in its mean (μ), with i.i.d normal innovations with volatility (σ). Thus, the agents update their belief according to the posterior probabilities computed as

$$\hat{\xi}_{t+1|t} = P\frac{\hat{\xi}_{t|t-1} \odot \zeta_t}{\mathbf{1}'\left(\hat{\xi}_{t|t-1} \odot \zeta_t\right)}, \tag{9}$$

where $\odot$ denotes the Hadamard product, ζ_t is a vector that stacks the conditional densities of the output growth rates:

$$\zeta_t = \begin{bmatrix} f\left(\Delta \log y_t \mid s_t = 1, \Omega_{t-1}\right) \\ \vdots \\ f\left(\Delta \log y_t \mid s_t = n, \Omega_{t-1}\right) \end{bmatrix} \tag{10}$$

with the density of $\Delta \log y_t$ conditional on state s_t is defined as:

$$f\left(\Delta \log y_t \mid s_t = i, , \Omega_{t-1}\right) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left\{-\frac{\left(\Delta \log y_t - \mu(s_t)\right)^2}{2\sigma^2}\right\}, \tag{11}$$

where Ω denotes the information set.

3 Data and Estimation

For our empirical tests, we use quarterly data focusing, given their availability, on the time period between 1987 to 2010. Data are mainly taken from the Area Wide Model (AWM) Database, constructed by Fagan et al. (2005), and from the OECD Main Economic Indicators database. Data from Eurostat, after being re-based to the same base year as for the AWM data (1996), are used to complete the AWM series, which end in the fourth quarter of 2009.

As a measure for short term nominal interest rate of the Euro area we use the 3-month Euro Inter Bank Offered Rate (EURIBOR) while, for the United Kingdom we use the 3-month London Inter Bank Offered Rate (LIBOR)[4].

Quarterly inflation rates are computed as the percentage change in the price indexes over the previous four quarters. For the Euro Area we use the Core Harmonized Index of Consumer Prices which is less volatile than the overall HICP as it excludes energy and unprocessed food prices. According to their availability, HICP data begin only in 1988q3.

To estimate United Kingdom's inflation rate we use a joint measure, instead. Until 2003 British inflation was officially measured by the Retail Price Index (RPIX). Since December 2003 the Harmonized Consumer Price Index (HICP) is used. Accordingly, from 1987 to 2003 we measure inflation using the Retail Price Index (RPIX); after that, from 2004 to 2010 the Core HICP (excluding energy and unprocessed food) is employed[5].

[4]Previous contributions (see e.g. Sauer and Sturm, 2003), are uncertain whether the EURIBOR or the EONIA (Euro Overnight Index Average) should be preferred as the reference interest rate for the Euro-Area. As a robustness check, we employ also the latter in our estimates finding very similar results.

[5]HICPs Data are provided by Eurostat, The RPIX index is extracted from The Office for National Statistics Database.

As is standard practice in literature, the output gaps are identified by analyzing data decomposed by a frequency filter. Our measure of cyclical output is obtained applying the Hodrick and Prescott (1997) filter to the real Industrial Production series. The output gap is then measured as the percentage deviation of the index from its potential level[6].

To estimate the regime switching model we employ for both countries the quarterly real GDP growth rate. The UK economy is estimated over the time period 1987 to 2010, while the European Union economy is estimated employing the series provided by The Area Wide Model Database.

Finally, as explained below, to estimate equation (5) and its regime-switching counterpart we use generalized methods of moments (GMM). Following Gerlach and Schnabel (2000), besides the current inflation rate, we use a set of instrumental variables to control for the role of the monetary and the exchange rate markets:

- *Money Growth rate* is calculated as the percentage annual variation of the overall index of the monetary aggregate M3 provided by the OECD Statistics Portal.

- *Federal Funds Rates* are quarterly averages of monthly figures that are provided by the Federal Reserve Bank of New York.

- *Dollar/Sterling real exchange rate* is measured as the Nominal Dollar per Sterling Rate multiplied by a price deflator. The price deflator is constructed as the ratio of UK Consumer Price Index and the United

[6]As suggested by Hodrick and Prescott (1997) we use a $\lambda = 1600$ for our quarterly database

States Consumer Price Index for All Urban Consumers published by the Bureau of Labor Statistics. The nominal exchange rate is provided by the Federal Reserve Bank of New York.

- *Euro/Sterling real exchange rate* is calculated as a crossed rate between the Dollar/Sterling real exchange rate and the Dollar/Euro real exchange rate provided by The Area Wide Model Database provided by Fagan et al. (2005).

3.1 Estimation procedure

Turning to the empirics, we carefully took care of possible econometric biases that can arise when estimating the two response functions. In the baseline linear model we account for possible serial correlation in the residuals by estimating equation (2) with a Prais and Winsten (1954) procedure, having its standard errors corrected for heteroscedasticity.

The same baseline reaction function under the regime switching hypothesis requires a three steps procedure. First, we estimate the regime switching model using a Markov-Chain Monte-Carlo (MCMC) procedure on the output series. In this, we closely followed the algorithm described in Section 9.1 of Kim and Nelson (1999), obtaining the estimated state beliefs ($\hat{\xi}_{t|t-1}$).

Second, to account for possible serial correlation, we "pre-whiten" the data and the regressors using the estimated serial correlation of residuals obtained from a standard ols regression. In particular, we estimate the autocorrelation as:

$$\hat{\rho} = \frac{\sum_{t=2}^{n}(e_t e_{t-1})}{\sum_{t=1}^{n} e_t^2}$$

where e are the residuals obtained by regressing the nominal interest rate on a constant, the inflation rate, and the output gap. Then, we adjust both the regressors and the dependent variable according to:

$$\begin{aligned} \tilde{Y}_{t+1} &= Y_{t+1} + \hat{\rho} Y_t \\ \tilde{X}_{t+1} &= X_{t+1} + \hat{\rho} X_t, \end{aligned}$$

where Y is the vector that stores the time series of the nominal interest rate and X is the matrix containing the inflation rate and the output gap.

Third, we estimate the policy function (6) by maximum-likelihood, using the state beliefs obtained from the MCMC estimation as weights for the monetary responses for each state of the economy. That is, we maximize[7]

$$\mathcal{L} = log(L)$$

with

$$L = \prod_{t}^{T} \hat{\xi}_{t|t-1}^{i} \left[\frac{1}{\sqrt{\pi \sigma_i^2}} exp\left(\left(\tilde{Y}_t - \hat{B}^i \tilde{X}_t \right) \left(\tilde{Y}_t - \hat{B}^i \tilde{X}_t \right)' / 2\sigma_i^2 \right) \right],$$

where $(i = 1, 2)$ indicates the state of the economy, and $\hat{B}$ is the vector of coefficients to be estimated.

[7]See Lütkepohl (2006), chapter 17.

In the forward looking extension of the model we employ a GMM procedure, with the expected inflation instrumented by a constant, the current inflation rate, and any other variable entering the model (see Clarida et al., 1998 and Gerlach and Schnabel, 2000). That is, we estimate:

$$i_t = \alpha^* + \beta^* \pi_{t+n} + \gamma^* g_t + \theta z_t + \rho i_{t-1} + \varpi_t, \tag{12}$$

where z_t indicates an additional instrumental variable taken from the list provided in section 3.

Turning to the regime switching specification, a similar methodology to the three steps procedure described for the baseline model is adopted to estimate equation (7). After having estimated the state beliefs ($\hat{\xi}_{t|t-1}$) with the MCMC algorithm, we instrumented the expected inflation rate using the same instruments as in the linear case. Finally, we estimate the policy function (7) again by maximum-likelihood using the state beliefs obtained from the MCMC algorithm as weights for the monetary responses for each state of the economy.

4 Results

The MCMC procedure outlined in subsection 2.1 gives comforting results when applied to the UK economy. The estimated probabilities of switching from the two states are 4.18% and 17.9%, respectively. This implies an average duration of almost 6 years for the high GDP growth rate state, and slightly more than one year for the low GDP growth rate state.

[Figure 1 about here.]

Figure 1 confirms that the model is able to pick up the historical business cycles of the UK economy. It plots the estimated posterior probability of being in the low mean state, showing how the Markov switching model is able to capture fairly well the UK recessions as chronicled by the official Bank of England business cycle dates[8] (the gray areas in the graph).

Turning to the EU economy, the MCMC estimates provide a probability of switching of 2.20% for the high mean state and of 19.78% for the low mean state. This implies an average duration of more than 11 years for the high GDP growth rate state, and slightly more than one year for the low GDP growth rate state.

[Figure 2 about here.]

The capability of picking up the EU business cycle seems less satisfactory. Figure 2 shows how the Markov switching model is able to capture two out of four of the recessions as chronicled by the CEPR business cycle dates[9] (the gray areas in the graph). This can be due to several reasons. Among these, may be of interest to recall that the CEPR dating committee claims that the EU "experienced a prolonged pause in the growth of economic activity" during the period 2001-2003 without ending up in a recession for the first two quarters of 2003. This period can mislead the MCMC algorithm in detecting the different states of the series.

As a first test of the two monetary policies, we estimate a standard Taylor Rule as the one reported in equation (2). Generally speaking, both the EU

[8]see Ryland et al. (2010).

[9]http://www.cepr.org/data/dating/

and the UK results, reported in table 1, show evidence of first order autocorrelation of the errors, supporting our choice of the estimation procedure.

Turning to the coefficients, when the whole sample is used, the estimates for the European Union are in support of a stabilizing policy towards the nominal indicator, while the business cycle indicator is indeed significant but statistically lower than the value 0.5 predicted by the Taylor principle and, more importantly lower than the coefficient on inflation by a factor of 10[10]. Interestingly, if we focus on the subsample starting when the ECB officially took control over the monetary policy (January 1999), these estimates show evidence of an accommodative policy with an inflation coefficient still higher than the output coefficient but less than one. So, even if the ECB seems to weight more the nominal indicator, it seems not to adhere to the Taylor principle.

On the contrary the Bank of England seems to follow an accommodative policy. In fact, when the rule is assessed on the whole sample, the coefficient on the inflation is estimated to be significant but well below unity (0.599). Interestingly, the coefficient of the output gap, even is significant, is estimated to be only 0.229. Thus, when the classical Taylor Rule is the benchmark, the BoE seems to weight more the inflation indicator[11]. We also provide estimates on the UK monetary policy during the same subsample of the EU ones. When the decade 1999-2010 is considered (see second column of table 1, UK panel) the estimates fail to confirm the classical Taylor Rule as we find a coefficient for the inflation not significantly different from zero. This

[10]To control for the exchange market pressures in the beginning of the nineties, we use the "dummy1992" indicator variable for the period 1992q3 to 1993q3.

[11]We added the "dummy1992" also in the UK regression. The indicator variable turns out to be significant, but the coefficients estimates are virtually non sensible to its inclusion.

latter result is probably attributable to the strong liquidity injection due to the Asset Purchase Facility (APF) started in March 2009 by the BoE to face the recent financial turmoil.

[Table 1 about here.]

Pushing our analysis further, in table 2 we provide estimates for the forward looking specification. In the first panel the EU estimates are provided. The first column reports the estimates for equation (5), while the rest of the columns show the results when a series of control variables are added, namely a liquidity indicator measured with the M3 rate of growth, the interest rates of both UK and US, the real exchange rates with US and UK, and the lagged inflation. The estimates show support in favor of a foreign interest rate as a control in the forward looking specification. In fact, when either the US or the UK nominal short term rates are employed both the output gap and the inflation coefficients are significant. On the contrary the monetary aggregate does not seem to have a role in the ECB conduct. This is somehow surprising given the strategy that the ECB claims to follow. In fact the ECB commitment to price stability is enforced by the wide agreement that the development of the price level is a monetary matter. According to this, monetary aggregates hold a favorable role in the monetary policy analysis because of their predictive power for the future path of the inflation rate in the medium and in the long term. That's why, since 1999 the ECB reserved a prominent role for the broader monetary aggregate (M3) within its "two pillar strategy".

In their 2011 bulletin (see *The Monetary Policy of the ECB* May 2011) they states that the "monetary analysis" pillar raises from the link between

M3 and inflation in the Euro Area, which is robust in the long run: the shifts in the trend of the money growth tend to influence the trend of the inflation rate, giving a nominal anchor to the expected inflation. Moreover, excessive money or credit growth are often conjoined with asset prices over-valuation phenomena: hence, monetary aggregates might serve as useful indicators for the detection of the imbalances in asset market dynamics. So the ECB Governing Council set a medium term reference value for the Monetary Aggregate and officially announced it in January 1999 clarifying that they would monitor the deviations of the money aggregate against its reference value on the basis of a three-month moving average.

However deviations of the money growth from its reference value may be due to both persistent and temporary factors. In the short run money growth might be affected by temporary changes in the money demand and in the money velocity. These factors don't threat the price stability in the medium term but do interfere with the link between money and prices in the short run.

Because of this informational limit, the ECB claims that they don't not mechanically react to all the deviations of M3, relying instead on a broader information set given by both monetary and non-monetary variables. In particular the ECB clearly states that the "economic analysis" pillar, which includes non monetary indicators of the real activity and cost factors, has lately, starting from the end of 2003, gained a greater relevance.

To further analyze this issue, we re-estimate equation (5) for the Euro area, using the percentage deviation of the monetary aggregate from its potential level calculated with the Hodrick and Prescott (1997) filter instead of its growth rate. When the whole sample is employed, we obtain the following estimates

$$i_t = -0.26 + 0.32^{*}\,\mathrm{E}_t\left[\pi_{t+n}\right] + 0.08^{***}\,\mathrm{E}_t\left[g_t\right] + 0.90^{***} i_{t-1} - 0.10^{**}\Delta M3_t,$$

where $*$ $**$ and $***$ indicate a significance level of 5%, 1% and 0.1% respectively. This confirms that a measure of the deviation of M3 is a better indicator of the "monetary analysis" pillar of the ECB. Moreover, when the same forward looking Taylor rule is estimated censoring the sample to the last quarter of 2003, we get a coefficient on $\Delta M3_t$ of -0.16, statisytically different from zero, indicating a closer attention to the second pillar of the "monetary analysis" in the beginning of the sample.

Focusing on the specification with the US short nominal rate as a control, to check for the relative strength of the policy responses we need to first recover the implied elasticities (β and γ) from the regression coefficients β^* and γ^*. The results confirm the strong preference for the price stability by the EU giving a value of the implied elasticities on inflation and output gap of 2.75 and 0.78 respectively[12].

[Table 2 about here.]

The second panel reports the same set of regression on the UK economy. The estimates seems to be fairly stable across the different specifications.

[12]When the UK nominal rate is used as a control, the implied elasticities are even diverging stronger with a value of 3.15 and 0.47 for the inflation and for the output gap respectively

In this case, the price stabilizing behavior of the Bank of England is confirmed with an implied elasticity on inflation ranging from 1.65 to 2.5, when both the output gap and the inflation coefficient are significant. Remarkably the implied elasticity on the output gap is always close to 0.5 implying an adherence of the BoE to the Taylor principle.

Clearly the linearity of the specifications tested above, do not help us in capturing if the Central Banks adjust their responses based on the business cycle they believe the economy is in. This can be particularly important if we want to assess the different responses to the real side of the economy. To overcome this problem we employ the estimation based on the regime switching model depicted is subsection 3.1.

Table 3 reports the estimates for equation (6). That is a simple Taylor Rule allowed to switch following the state of the economy. It is worth noting that the BoE has a stabilizing policy regardless of the business cycle. Consistently with the hypothesis that the real side of economy is more considered during a low growth period, the coefficient of the output become significant and positive only during recessions (see column 1). Interestingly the ECB shows a different behavior when regimes are accounted for. In particular the inflation coefficient is now well above unity during both states of the economy and rises to 3.7 during busts. Moreover, in this case the coefficient of the output become significant and positive only during booms.

[Table 3 about here.]

Finally the regime based forward looking model introduced in equation (7) is tested. Results reported in table 4 confirm the intuition of its linear counterpart. On the whole sample (see column 1), The BoE has a stabilizing inflation targeting during booms (the implied elasticity β is ranging from 2.04 to 2.47), maintaining basically the same policy during recessions. On the opposite, output becomes more relevant during recessions. In fact, while in boom periods the value of its implied elasticity is well below one, during recessions the implied elasticity jumps up above one with values between 1.02 to 1.32. This confirms that, when the state of economy is considered, the Bank of England does pay a higher attention to the real side of economy when is needed (i.e. during recessions).

Turning to the EU estimates, the results are less satisfactory in terms of different response of the Central Bank based on the state of the economy. The last two columns of table 4 show that the ECB focuses on a stabilizing inflation targeting regardless of the state of the economy (the implied elasticities associated with the inflation are 2.86 and 1.92 during booms and 3.39 and 2.49 during recessions respectively). On the contrary, the responses to output are well below one during booms, turning to not statistically significant when the fed funds are used as control variable.

Summarizing, we find compelling evidence that the EU follows a stabilizing policy with respect to the price stability target. This is robust to different extensions of the classical Taylor Rule and is confirmed when economic regimes are accounted for. Interestingly when the real indicator is considered, the estimates shows a low elasticity of the response to the output gap.

Turning to the BoE estimates, we found evidence of a stabilizing policy towards the price stability target as well, especially when the autoregressive behavior on the interest rate (i.e. in the forward looking specification) is considered. Moreover, our results support the closer attention paid by the UK monetary authority to the real indicator. The stronger response to the output gap, with respect to the ECB conduct, becomes clearer when we adjust our estimate for the business cycles.

[Table 4 about here.]

5 Conclusion

We focused on a comparison between the Bank of England and The European Central Bank monetary conducts. The comparative estimates of the Taylor Rule proposed in this paper adds to the previous literature as they contextualize the monetary choices of the two authorities within the process of integration in Europe, which is not yet complete. In 1992, by exercising the opt-out clause from the EU law concerning the monetary union, the United Kingdom has deferred the choice to adhere to the European Monetary Union. British monetary authorities raised and still confirm deep concerns about the exhaustiveness of the Maastricht criteria and the economic benefits the United Kingdom could enjoy by entering the Eurozone.

Our empirical results seems to support the British claims: when we take into account interest rate smoothing the BoE estimates comply with the Taylor principle showing a stabilizing behavior with respect to prices and a stronger response to the gdp cycle. This latter behavior seems not to be followed by the ECB monetary conduct, whose estimates of the elasticity to the real indicator show values consistently less than the ones obtained for the BOE. Interestingly, these results are robust to a regime switching specification, where the monetary authorities set their policy responses based on the inferred beliefs of being in a particular state of the economy.

References

Altavilla, Carlo and Landolfo, Luigi (2005). Do central banks act asymmetrically? Empirical evidence from ECB and the bank of England. *Applied Economics* 37, 205–208.

Clarida, Richard and Gali, Jordi and Gertler, Mark (1998) Monetary policy rules in practice. Some international evidence. *European Economic Review* 42, 1033–1067.

Dolado, Juan J. and Maria-Dolores, Ramon and Ruge-Murcia, Francisco J. (2004) Nonlinear Monetary Policy Rules: Some New Evidence for the U.S. *Studies in Nonlinear Dynamics and Econometrics* 8, Issue 3, Article 2.

Dolado, Juan J. and Maria-Dolores, Ramon and Naveira, Manuel (2005) Are monetary-policy reaction functions asymmetric?: The role of nonlinearity in the Phillips curve *European Economic Review* 49, 485–503.

Fagan, Gabriel and Henry, Jerome and Mestre, Ricardo (2005) An area-wide model for the euro area *Economic Modelling* 22, 39–59.

Gerlach, Stefan and Schnabel, Gert (2000) The Taylor rule and interest rates in the EMU area *Economics Letters*, 67, 165–171.

Goodfriend, Marvin (1991) Interest rates and the conduct of monetary policy. *Carnegie-Rochester Conference Series on Public Policy* 34, 7–30.

Hamilton, James D. (1989) A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica*, 55, 357–384.

Hodrick, Robert and Prescott, Edward (1997) Post-war US business cycles: An empirical investigation. *Journal of Money, Credit, and Banking* 29, 116.

Kim, Chang-Jin and Nelson, Charles R. (1999). *State-Space Models with Regime Switching*. Cambridge and London: MIT Press.

Lütkepohl, Helmut (2006) New Introduction to Multiple Time Series Analysis. *Springer* 2006.

Meyer, Laurence H. and Swanson, Eric T. and Wieland, Volker W.(2001) NAIRU Uncertainty and Nonlinear Policy Rules. *The American Economic Review* 91, 226-231.

McCallum, Bennett T. Alternative Monetary Policy Rules: A Comparison with Historical Settings for the United States, the United Kingdom, and Japan *Economic Quarterly* 86, 49–79

Nelson, E. UK Monetary Policy 1972-97: a guide using Taylor Rules *Bank of England WP series* 120.

Peersman, G. and Smets, F. (1999) The Taylor Rule, a Useful Monetary

Policy Benchmark for the Euro Area? *International Finance* Vol 2, 85–116.

Prais, G. J. and Winsten, C.B. (1954) Trend Estimators and Serial Correlation *Cowles Commission Discussion Papers* 383.

Nobay, A.R. and Peel, D.A. (2000). Optimal monetary policy with a nonlinear Phillips curve. *Economics Letters* 67, 159–164.

Ryland, Thomas and Hills, Sally and Dimsdale, Nicholas (2010) The UK recession in context- what do three centuries of data tell us? *Bank of England Quarterly Bulletin* 50, 277–291.

Sack, Brian and Wieland, Volker (2000). Interest-rate smoothing and optimal monetary policy: a review of recent empirical evidence. *Journal of Economics and Business* 52, 205–208.

Sauer, S. and Sturm, J.E. (2003). ECB monetary policy: how well does the Taylor rule describe it? *mimeo.*

Surico, Paolo (2007) The Fed's monetary policy rule and U.S. inflation: The case of asymmetric preferences. *Journal of Economic Dynamics and Control* 31, 305–324.

Taylor, John (1993) Discretion versus policy rules in practice. *Carnegie-Rochester Conference Series on Public Policy* 39, 195–214.

Taylor, John (1999). Robustness and Efficiency of Monetary Policy Rules as Guidelines for Interest Rate Setting by the European Central Bank. *Journal of Monetary Economics.* 43, 655–679.

Figure 1: Posterior probabilities of a low growth rate in UK

This figure shows the estimated posterior probabilities of being in a recession coupled with the official BoE recession dates (shadow area). Data employed in the estimation are quarterly starting from 1987.

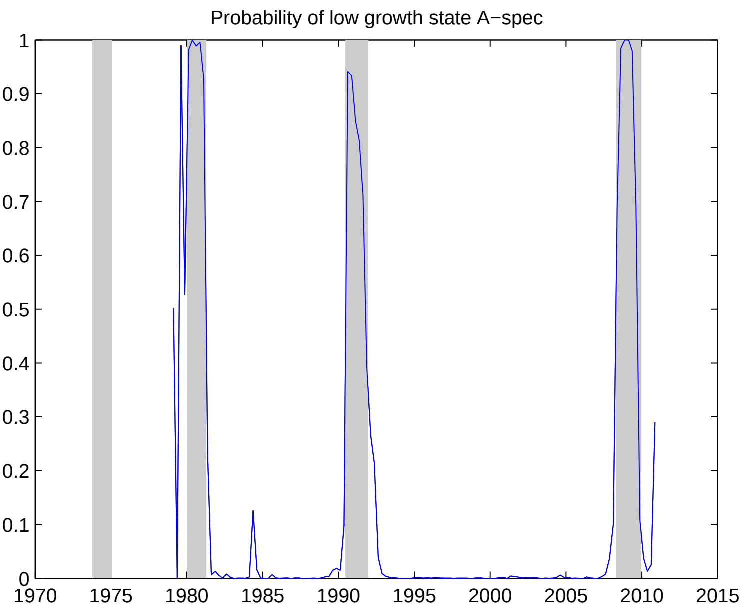

Figure 2: Posterior probabilities of a low growth rate in EU

This figure shows the estimated posterior probabilities of being in a recession coupled with the official CRSP recession dates (shadow area). Data employed in the estimation are quarterly starting from 1970.

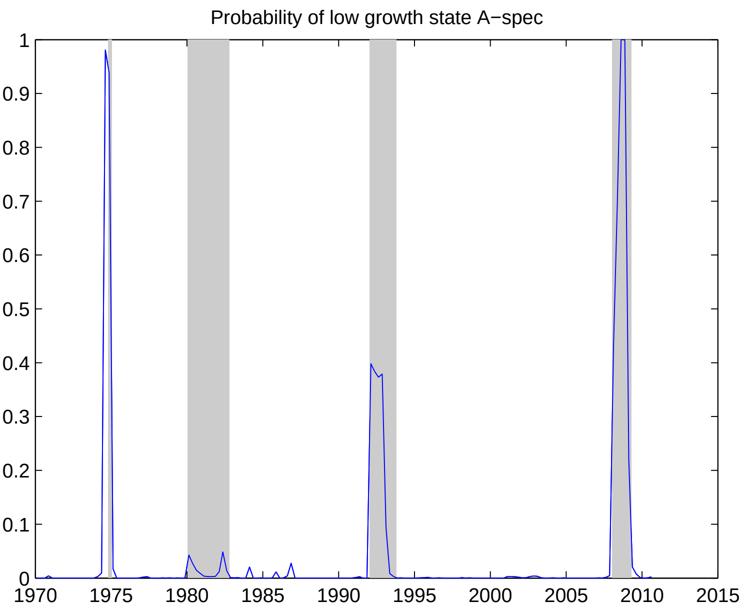

Table 1: Simple Taylor rule

This table reports the estimates of the baseline Taylor rule introduced in equation (2). The dependent variable are the short term nominal interest rates.

	European Union	
	1989q1-2010q3	1999q1-2010q3
Infl. (β)	1.22***	.631*
Out. gap (γ^*)	.129***	.147***
dummy1992	1.2***	
Cons	2.41**	1.8**
ρ	0.903	0.817
Adj. R^2	0.576	0.556
Obs.	87	47
F	23.414	58.820
p-value	0.000	0.000
	United Kingdom	
	1987q1-2010q3	1999q1-2010q3
Infl. (β)	.599***	.0148
Out. gap (γ^*)	.229*	.32**
dummy1992	.395*	
Cons	4.67***	4.24***
ρ	0.389	0.774
Adj. R^2	0.479	0.500
Obs.	95	47
F	24.999	55.731
p-value	0.000	0.000

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2: Forward looking

This table reports the estimates of the forward looking model in equation (5)

				European Union			
E. infl (β^*)	.102	.388	.396*	.767***	.149	.154	.174
Int. rate (-1) (ρ)	.947***	.877***	.762***	.721***	.943***	.938***	.921***
Out. gap (γ^*)	.096***	.112***	.0589***	.0492*	.0839***	.0887***	.0952***
dummy1992	.0262	.2	.546	.524	.0319	.046	.109
M3 growth		-.0739					
Int. rate UK			.113***				
Int. rate US				.098**			
Exch. rate UK EU					.587		
Exch. rate EU US						-.695	
Lagged Infl.							-.00278
Cons	-.0458	.217	-.466**	-.728***	-.96	.387	-.0745
Adj. R^2	0.985	0.988	0.988	0.982	0.986	0.985	0.987
Obs.	83	83	83	83	83	83	82
χ^2	4689.465	5601.964	5663.510	4099.278	5016.842	4810.791	5218.853
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000
				United Kingdom			
E. infl (β^*)	.335*	.377*	.338*	.334*	.425*	.366*	.489*
Int. rate (-1) (ρ)	.83***	.848***	.797***	.825***	.792***	.813***	.835***
Out. gap (γ^*)	.131*	.191***	.132*	.125**	.0875	.0998	.0846
dummy1992	.126	-.249	-.0263	.135	.357	.185	.121
M3 growth		-.0776**					
Int. rate EU			.0396				
Int. rate US				.0123			
Exch. rate UK EU					1.54**		
Exch. rate UK US						1.16*	
Lagged Infl.							-.103
Cons	.0106	.572*	.0234	-.00393	-2.19*	-1.91*	-.17
Adj. R^2	0.962	0.967	0.962	0.962	0.954	0.961	0.942
Obs.	93	89	93	93	93	93	93
χ^2	2712.641	3147.983	2836.550	2798.859	1821.105	3084.973	1276.039
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: Simple Taylor rule with regimes

This table reports the estimates for equation (6) in the regime switching model

	UK	EU
	Boom	
Cons. (α)	1.236***	-0.507***
Infl. (β)	1.457***	2.704***
Out. gap (γ)	0.147	0.201**
	Recession	
Cons. (α)	0.876**	-2.182***
Infl. (β)	1.413***	3.700***
Out. gap (γ)	0.232*	-0.0447
ρ	0.813	0.879
Adj. R^2	0.76	0.81
Obs.	95	87

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Regimes

This table reports the estimates for equation (7) in the regime switching model

	UK		EU	
Boom				
Cons. (α^*)	0.049	0.548***	-0.539***	-0.371***
Int. rate (-1) (ρ)	0.785***	0.783***	0.801***	0.833***
E. infl. (β^*)	0.438***	0.522***	0.569***	0.321***
Out. gap (γ^*)	0.076**	0.1313***	0.062***	0.068***
M3 Growth		-0.072***		
Fed funds			0.063***	
Int. rate UK				0.070***
Recession				
Cons. (α^*)	-0.178	1.849***	-1.894***	-1.451***
Int. rate (-1) (ρ)	0.893***	0.798***	0.576***	0.103***
E. infl. (β^*)	0.215***	0.390***	1.437***	2.233***
Out. gap (γ^*)	0.141**	0.210***	0.007	-0.130***
M3 Growth		-0.203***		
Fed funds			0.159***	
Int. rate UK			0	0.242***
Adj. R^2	0.97	0.97	0.98	0.99
Obs.	93	89	82	82

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$