Taylor Rules and Interest Rate Smoothing in the US and EMU

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Abstract

In this paper we estimate simple Taylor rules paying a particular attention to interest rate smoothing. Following English, Nelson, and Sack (2002), we employ a model in first differences to gain some insights on the presence and significance of the degree of partial adjustment. Moreover, we estimate a nested model to take both interest rate smoothing and serially correlated deviations from various Taylor rate prescriptions into account. Our findings suggest that the lagged interest rate enters the Taylor rule in its own right, and may very well coexist with a serially correlated policy shock. Asymmetric preferences on the output gap level and financial indicators turn out to be important factors to understand Greenspan's policy conduct. By contrast, our findings support standard regressors for a 'European' Taylor rule.

JEL classification system: E4, E5.

Keywords: Taylor rules, omitted variables, serial correlation, interest rate smoothing.

1 Introduction

Researchers involved in monetary policy analyses have been discussing about the Taylor (1993) rule for a decade now. This simple rule, which links the inflation rate and a measure of the output gap to the monetary policy rate, has turned out to be a satisfactory approximation of the various Central Banks' policy conducts all over the world. In fact, numerous researchers have focussed their attention on a *modified* Taylor rule, which reads as follows: $i_t = (1 - \rho) \overset{\frown}{i}_t + \rho i_{t-1}$, with i_t identifying the short term nominal interest rate controlled by the Central Bank (CB henceforth), while $\overset{\frown}{i}_t$ is the original Taylor rule, whose implied policy rate level has been termed 'Taylor rate'. The modified Taylor rule suggests a *partial*, gradual adjustment to the Taylor rate after that a shock has hit the economy. Notably, the estimated degree of partial adjustment ρ has typically turned out being very high, then suggesting the existence of the so-termed *interest rate smoothing*, or *monetary policy inertia*.[1]

Indeed, the literature has offered various sensible reasons to interpret the estimated policy gradualism.[2] Nevertheless, Rudebusch (2002) criticizes this conventional wisdom. In his stimulating contribution, he claims that *the interest rate smoothing at quarterly frequencies is just an illusion*. Rudebusch tests for the Partial Adjustment (PA hereafter) hypothesis, i.e. the interest rate smoothing one, vs. the Serial Correlation (SC) alternative, which is related to persistent deviations of the policy variable from the Taylor rate due to extraordinary episodes, such as shocks having a persistent effect on the economic system, or financial turbolences. In Rudebusch's work, a *direct* prove of the existence of this illusion, based on the estimation of Taylor rules admitting the smoothing component and an AR(1) process for the error term, turns out to be not definitive.[3] Then, the author goes for an *indirect* proof. In a nutshell, his reasoning is the following: If the partial adjustment strategy had such a high importance in the policy rate setting, then rational agents should be capable to predict future values of the quarterly rate with a high degree of precision. On the contrary, standard term structure regressions show how unpredictable the policy rate is over one quarter. Rudebusch takes this evidence as convincing to claim that the *quarterly* interest rate smoothing is just negligible, and that the per-

[1] Clarida, Galí, and Gertler (1999,2000) estimate such a partial adjustment degree with various specifications of the Taylor rule with US data, finding a magnitude $\simeq 0.8$. The same magnitude is found by Kozicki (1999), Amato and Laubach (1999), Domenéch, Ledo, and Taguas (2002). Estimates for some other industrialized countries are offered by Clarida, Galí, and Gertler (1998), Peersman and Smets (1999), Gerlach and Schnabel (2000), and Domenéch, Ledo, and Taguas (2002). Notice that Amato and Laubach (1999) estimate a slightly different version of the modified Taylor rule, which is : $i_t = \overset{\frown}{i}_t + \rho i_{t-1}$.

[2] Discussions concerning the interest rate smoothing issue may be found in Lowe and Ellis (1998), Goodhart (1999), Sack and Wieland (2000), Cecchetti (2000), and Srour (2001). In Section 2 we list some of the reasons why monetary policy gradualism may be seen as an optimal strategy.

[3] High correlation in the Taylor rule's regressors, their dynamic endogeneity, small sample bias, and uncertainty about the appropriate arguments of the historical policy rate are among the motivations put forward by Rudebusch (2002, pp. 1178-1179) to justify the lack of power regarding the PA vs. SC test constructed on his nested model.

sistency of the observed policy rate is due to serially correlated *deviations* from the Taylor rate. As far as the Fed is concerned, such deviations could be due to particular circumnstances, e.g. commodity price scares (1988-89 and 1994-95), credit crunches (1992-93), and financial crises (1998-99).[4]

Söderlind, Söderstrom, and Vredin (2002, SSV henceforth) go a step further. By working with an AD-AS model, they show that with model consistent rational expectations on the interest rate *change*, the predictability of the latter increases as the PA parameter ρ becomes larger. SSV underline how a high ρ is a *necessary but not sufficient* condition to effectively predict the policy rate variations; indeed, this predictability also comes from the high forecastability of variables such as the inflation rate and the output gap level.[5] SSV (2002) also verify, with survey data and a small VAR model, that the predicability of the short term interest rate change is very low (as also shown by Rudebusch 2002). Then, they conclude that a high degree of PA cannot co-exist with a standard Taylor rate, given that the latter is composed by highly predictable variables, and this would indeed imply largely forecastable policy rate changes. In SSV (2002)'s opinion, there might be an omitted variable problem in the Taylor (1993) rate $\widehat{i}_t$ definition. Notice that, to be consistent with an high degree of PA, this potentially missing variable should not be easily predictable, because otherwise it would be rejected by the yield curve *indirect* test.[6]

A reply to Rudebusch (2002)'s conjecture is offered by English, Nelson, and Sack (2002, ENS hereafter). These authors, working on the *first differences* of the policy rate, show that it is possible to test *directly* the null of SC vs. the alternative of PA as determinants of the policy rate historical path. Their findings indicate a significant role for the latter; nevertheless, a *nested* model seems to be suited for capturing the policy rate behavior. Gerlach-Kristen (2002) also comments on Rudebusch (2002)'s contribution.

[4] In fact, in drawing the conclusions of his paper, Rudebusch (2002a) acknowledges for the possibility of "[...] some intermediate case of partial adjustment, [...] along with some serially correlated shocks, that is not strictly rejected by the term structure evidence".

[5] When SSV (2002) make the hypothesis that both inflation and output gap are white noise, they find that the larger the PA coefficient ρ, the *less* predictable future changes in the policy rate are. This is indeed intuitive, thinking about a sequence of levels of the interest rate very close to each other; in this case, the predictability of the *change* of the policy rate will be very low.

[6] This last statement finds its basis on the Rational Expectation Hypothesis, i.e. the hypothesis that the yield curve is the outcome of a game played by fully rational agents. In fact, most of the empirical literature reject the expectations model of the term structure. As an exception on this point, see Favero (2002).

In her paper she investigates the role of omitted variables in the estimation of the Taylor rule. By using Kalman filtering, she finds that both PA and a financial indicator such as the risk-premium are important components in replicating the observed federal funds rate path.

In this paper we extend ENS (2002)'s analysis along two dimensions. First, in exploiting their modeling strategy we consider a richer set of alternative Taylor rate definitions. In particular, we take into account diverse, possibly important omitted variables, so capturing the stimuli coming from Clarida, Galí, and Gertler (1998, CGG henceforth), Gerlach and Schnabel (2000), SSV(2002), Cukierman and Gerlach (2002), Surico (2002), and Gerlach-Kristen (2002). Second, we focus our attention both on US data and on EMU variables, in order to gain some insights also on the European aggregate. As far as the latter is concerned, we are in practice considering the possibility of estimating Taylor rules for the EMU area, so gaining some insights regarding the 'average' European conduct of monetary policy. In doing so, we have to keep in mind all the possible *caveats* relative to the use of aggregated data regarding different countries having probably different monetary policy targets, e.g. the inflation target. However, we think that this exercise could be considered as a first-order approximation of the track followed by the EMU aggregate during the last two decades.

Our results indicates that both US and European data largely support the partial adjustment mechanism hypothesis. Indeed, in the American case some serial correlation is swept away by embedding in the Taylor rate definitions variables proxing asymmetric preferences of the CB on the output gap, or financial indicators. By contrast, a forward looking Taylor rules with interest rate smoothing turns out to be a satisfactory descriptive model for EMU.

The structure of the paper reads as follows. In Section 2 we list a few reasons why a CB might be willing to implement a gradual policy rate path. Section 3 explains Rudebusch (2002)'s point regarding the conventional wisdom on monetary policy inertia. In the same Section, the identification problem affecting a test performed with a model in levels is highlighted, and English, Nelson, and Sack (2002)'s alternative strategy is described. In Section 4 we present the alternative specifications of the Taylor rate we employ in our analysis, while in the following Section we discuss our findings. Then, in Section 6 we make a qualitative point regarding the 'real time vs. revised' data discussion which has been very lively in this literature in the past few years. Section 7 concludes. A Data appendix is included. References follow.

2 Rationalizing monetary policy gradualism

The issue of dynamics is important from a policy perspective. In fact, in the last two decades we have observed an improvement of the inflation-output gap trade-off in many industrialized countries. Part of this improvement is surely attributable to a better monetary-policy management, as remarked by Cecchetti, Flores Lagunes, and Krause (2001) and Favero and Rovelli (2003).[7] In general, it is important to understand the causes of this successful management, in order to possibly replicate this success in presence of future, similar macroeconomic conditions. Among these causes, may monetary policy gradualism have played an important role? Recent research in monetary policy has indicated various possible reasons for a CB to move in a moderate manner its policy rate. In this section, we quickly discuss some of them.

Private Sector Expectations

It is well known that, in absence of a commitment technology, the CB is incapable to manipulate the private sector expectations, due to the time-inconsistency feature of its promises of fighting inflation which renders these promises non-credible (Kydland and Prescott, 1977). Indeed, this leads the Society to an inferior level of efficiency with respect to that coming from a solution under commitment, as explained by Rogoff (1985). In studying this problem, Woodford (1999) suggests the possibility to reduce the gap existing between these two solutions. He proposes to induce the CB to target an interest rate smoothing argument, i.e. to control the volatility of the interest rate *change*. In doing so, an optimally behaving CB would implement an inertial interest rate close to the one that it would set under the commitment scenario. This because the inertia implied by the interest rate smoothing targeting would have an effect on the economic system through private sector expectations as if the CB owned a commitment technology.

Parameter Uncertainty

In the real world, monetary policy-making is an exercise undertaken in an uncertain environment (Goodhart, 1999). Indeed, the CB does face a

[7] The same authors underline that the improved inflation-output gap trade-off has probably not been uniquely caused by a better monetary policy management. In fact, there is a certain evidence of a change in monetary policy preferences, and of more favourable sequences of supply shocks. Still, better monetary policy management seems to have been quite significant.

lack of information concerning the monetary transmission mechanism. One of these uncertainties regard the parameters linking the aggregates which compose the relevant economic environment the CB is interested into. The first impacting contribution in this context was Brainard (1967)'s. His story is simple: a CB that is partially ignorant relatively to the key-parameters of the economy may implement prudent monetary actions when responding to shocks, since in this way it will reduce the 'uncertainty cost', i.e. the possibility of inducing a large volatility in the economy due to a misinterpretation of the monetary transmission mechanism.[8] Söderstrom (1999) and Sack (2000) empirically demonstrate that in an optimal control context with VAR representations of the economic dynamics it is possible to replicate fairly well the federal funds rate path if taking into account parameter uncertainty.[9]

Model Uncertainty

McCallum (1999) sustains that a good policy rule is the one that is capable to perform well across many different models. In fact, not only a CB is uncertain about the key-parameters of the equations formalizing the economy; indeed, the CB's uncertainty refers to the formalization of the whole economic framework. Empirical contributions by Favero and Milani (2001) and Castelnuovo and Surico (2003), conducted in a class of linear backward model, show that considering many diverse models may lead the CB to implement a gradual, optimal monetary policy. Indeed, model uncertainty may be an important component in tracking the CB's historical policy rate path.

Learning

Does learning enhance gradualism? Sack (1998) shows how a CB that periodically refines his estimates of the key-parameters linking the variables

[8] It should be noticed that in his contribution Brainard (1967) points out how this result is driven by the low covariance existing between the policy instrument and the state variables; indeed, a high covariance could overturn the result.

[9] However, there is not yet a complete agreement on the link between this type of uncertainty and the optimal CB's behavior. In fact, Söderstrom (2002) suggests that uncertainty related to the persistence of the inflation mechanism may induce CBs to implement an aggressive strategy, in order to reduce the uncertainty about the future development of inflation. Robust-control oriented works, such as those by Sargent (1999) and Onatski and Stock (2002) show that the best possible reaction of the CB to the worst-scenario drawn by the Nature is an aggressive monetary action. Finally, with the use of small scale models and focusing just on a few key-parameters, Estrella and Mishkin (1999), Peersman and Smets (1999), and Rudebusch (2001) claim that parameter uncertainty seems not to have an important impact on the optimally determined feedback rule coefficients.

of interest in a given framework may choose to act gradually. This result is due to the stochastic features of the economic dynamics, that render particularly informative the most recent observations. As a result, the Fed faces more uncertainty about the reaction of the economy as it moves the funds rate away from its recent levels.[10]

Data Uncertainty - Measurement Error

Orphanides (1998) offers an important contribution regarding the noise affecting the data. His point is intuitive: CB should respond to shocks gradually, because it is difficult to understand if the one under consideration is a pure economic shock, or just a measurement error (or a mix between the two). Indeed, when simple rules à la Taylor (1993) are taken into account, the increase in volatility caused by measurement errors matters.[11]

Financial Markets Reaction

A cautious monetary policy may also reflect the attention that the CB poses to the reactions that financial markets exert after that a monetary policy decision has been implemented. In fact, Goodfriend (1991)'s claim is that markets could over-react to a series of swings of the reference nominal rate, so negatively affecting the real side of the economy.[12]

[10] However, Sack (1998) himself and Wieland (2000) point out that there exist a dynamic trade-off between gradualism and learning, i.e. it may become optimal in a dynamic set-up to implement an aggressive policy in order to learn how the economy react to new, different monetary policy shocks. Indeed, an aggressive policy might speed up the learning process. Nevertheless, this approach, termed *experimentation* (see Bertocchi and Spagat, 1993, and Caplin and Leahy, 1996), do not seem to be supported by Policy Makers' official declarations. In fact, it is worth to mention a comment by a former Vice-Chairman of the Fed, Alan Blinder (1998, p.11): "You don't conduct experiments on a real economy solely to sharpen your econometric estimates".

[11] Notice that this does not hold if we consider the policy rule coming from first principles in a linear-quadratic context. For a formal demonstration of this application of the certainty equivalence principle, see Ljungqvist and Sargent (2000, chapter 4).

[12] An interesting point tackling this view is provided by Cecchetti (2000), who underlines how large jumps in the policy instrument could be disruptive only if financial markets are relatively certain that it will never happen. If market participants expect that new information can precipitate large and sudden interest rate changes, then they will defend themselves by building up institutions in order to avoid any negative consequence. In his opinion, the only reason that people believe smooth interest rates enhance financial stability is because interest rate has been smooth up to now.

3 Partial adjustment versus serial correlation: A direct test

Rudebusch (2002) performs an indirect test on the importance of PA versus SC. He exploits standar term structure regressions in order to show that the predictive power of the market regarding future changes of the short-term interest rate over a quarter is very low. Then, Rudebusch's claim is that interest rate levels cannot be explained by a large degree of PA, because this would lead to a easily forecastable variation of the policy rate. In fact, Rudebusch (2002) also tries to test directly the non-significance of the PA hypothesis. Formally, he builds up an empirical model nesting the PA specification

$$i_t = (1-\rho)\,\tilde{i}_t + \rho i_{t-1} + \eta_t \tag{1}$$

(η_t = white noise process) with the SC specification

$$i_t = \tilde{i}_t + \varepsilon_t,\ \varepsilon_t = \rho_\varepsilon \varepsilon_{t-1} + \eta_t \tag{2}$$

(ε_t = AR(1) process).[13] The nested model reads as follows:

$$i_t = (1-\rho)\,\tilde{i}_t + \rho i_{t-1} + \varepsilon_t,\ \varepsilon_t = \rho_\varepsilon \varepsilon_{t-1} + \eta_t \tag{3}$$

As far as the Taylor rate $\tilde{i}_t$ is concerned, Rudebusch concentrates on two different formalizations. The first one is the original Taylor (1993) rate, which reads as follows:

$$\tilde{i}_t = c + b_\pi\,\bar{\pi}_t + b_y y_t \tag{4}$$

where c is a constant, $\bar{\pi}_t$= four quarter average inflation rate, and y_t = output gap.[14] This is a natural benchmark definition of the Taylor rate.[15]

[13] We performed some econometric exercises in order to measure which is the serial correlation order featuring the residuals of simple backward and forward looking Taylor rules without smoothing. We did that both with American and with aggregated European data. Our findings suggest that an AR(1) process is a good approximation of the errors. We did not include these figures in the paper for sake of brevity; however, these figures are available upon request.

[14] The variables definition may be found in the Data appendix. About the Taylor rate definitions, notice that they do not have any error term, since the policy deviations with respect to the suggested rate are represented in our set up by the vector η_t.

[15] In Taylor (1993), the policy rule reads as follows: $i_t = \pi_t + 0.5y_t + 0.5(\pi_t - \pi^*) + r^*$, with $\pi^* = r^* = 2\%$. Then, the constant c in the various Taylor rates is a linear convolution

A different specification of the Tayor rate has been popularized by CGG (1998,1999,2000). These authors have underlined the importance for the CB to adjust the policy rate with respect to *future*, forecast movements of both inflation and output gap. Their idea finds its rationale in the lags affecting the monetary policy transmission.[16] Their definition of the Taylor rate can be captured by the following modelization:

$$\widetilde{i}_t = c + b_\pi E_{t-1}\, \overline{\pi}_{t+4} + b_y E_{t-1} y_t \tag{5}$$

Then, by working with equation (3) and - alternatively - (4) or (5), Rudebusch (2002) tests first for the significance of the PA, then for that on SC. The test suggests rejection neither for PA nor for SC. Why so? Rudebusch explains that there is an identification problem at this point. In fact, it is very difficult to distinguish between the dynamics deriving from a PA mechanism and those induced by a SC specification when observing at the realizations of the policy rate, since both these processes (which are very different from an economic standpoint) may induce the same (or similar) path of the policy rate.[17]

The importance of the contribution by ENS (2002) relates exactly to this identification issue. They notice that while the two different specifications (1) and (2) have similar implications for the behavior of the interest rate *level*, this similarity does not hold anymore when *first differences* are taken into account. To see that, consider equation (1). Making some algebra, it is possible to arrive to the following formulation:

$$\Delta i_t = (1-\rho)\Delta \breve{i}_t + (1-\rho)(\breve{i}_{t-1} - i_{t-1}) + \eta_t \tag{6}$$

Differently, the SC specification (2) leads to this alternative equation:

$$\Delta i_t = \Delta \breve{i}_t + (1-\rho_\varepsilon)(\breve{i}_{t-1} - i_{t-1}) + \eta_t \tag{7}$$

The latter equation sheds some light on the implications of the SC engine. Here, variations of the Taylor-rate cause an immediate and full reaction of the policy rate change; in fact, there is no inertial adjustment, which is by

of the inflation target π^* and the real interest rate of equilibrium r^*, i.e. $r^* - (b_\pi - 1)\pi^*$. Neither in Rudebusch (2002)'s nor in our study the focus is the one of assessing these elements; for investigations concentrating on these components, see Judd and Rudebusch (1998), and Domenéch, Ledo, and Taguas (2002).

[16] An already 'classical' reference for the dynamics of the monetary policy transmission is Christiano, Eichembaum, and Evans (1998).

[17] See Rudebusch (2002)'s discussion at page 1178.

contrast present in equation (6) via the coefficient $(1-\rho)$. Then, it is possible to build up a direct test on the PA vs. SC hypotheses. ENS estimate the empirical model

$$\Delta i_t = \gamma_2 \Delta \breve{i}_t + \gamma_3 (\breve{i}_{t-1} - i_{t-1}) + \eta_t \tag{8}$$

and test the null hypothesis

$$H0_{SC} : \gamma_2 = 1 \tag{9}$$

Under the null (9), the SC specification holds true. Notice that a rejection of the null hypothesis has clear economic implications, namely a rejection of the pure SC hypothesis as the unique driving force of the gradual policy rate path implemented by the CB. ENS verifies that the null is undoubtly rejected, so supporting a process in which PA plays a significant role.

In fact, there is no reason to belive that only one of the two hypotheses holds. Indeed, both PA and SC could be important in fitting the actual monetary policy rate. ENS build up and test a nested structure equivalent to (3), finding that both PA and SC are supported by the data. So, even in presence of a SC component the data seem not to discard the PA specification.

To summarize, ENS (2002) tackle the identification problem raised by Rudebusch (2002) and succeed in constructing a test to directly support the importance of the PA hypothesis in describing the Fed's decisions during Greenspan's regime.

In our positive exercise, we extend ENS's contribution along two dimensions. First, when testing for the PA vs. SC hypotheses, we allow for different specifications of the Taylor rate. In particular, we consider some possibly important 'omitted variables', in order to check if these omissions are capable to (at least partially) offset the high degree of PA recorded so far in the literature. The second dimension is the geographical one: We consider both US and EMU data. The latter are weighted data regarding all the countries belonging to the EMU area, and may serve an approximation of the monetary policy conduct of the EMU area as a whole. In the next Section we fully describe our approach, and we comment our findings.

4 PA versus SC: alternative Taylor rate specifications

Before exploiting the estimation strategy set up by ENS (2002), we have to specify the Taylor rate $\widetilde{i}_t$. Naturally, we consider the already commented modelizations (4) and (5). However, as already mentioned above, Rudebusch (2002) calls for omitted serially correlated variables as potential cause of the estimated high degree of PA. To check also for this, we enrich the original specification (4) by adding a third regressor, as follows:

$$\widetilde{i}_t = c + b_\pi \, \overline{\pi}_t + b_y y_t + b_z z_t \qquad (10)$$

In our exercise, the regressor z_t plays different roles. A variable that we want to control for is a quadratic transformation of the output gap level, i.e. $z_t = y_t^2$. In doing so we feel inspired by recent works on CBs' asymmetric preferences, which imply a non-quadratic representation of their loss function.[18] Many normative analyses conducted so far have relied on a quadratic formalization of the CB's penalty function. Indeed, apart from analytical tractability, there does not seem to be an obvious reason why a CB should symmetrically target the output gap measure (Blinder, 1997; Goodhart, 1999; Mayer, 2002). With our simple modeling strategy we try to capture possible asymmetries related to the real object.

We also want to control for the impact of financial market conditions. This seems to be an interesting check, given the lively discussion that has been taken place for a couple of years now on the attention that the CB should pose on financial markets.[19] In particular, z will be a measure of *credit spread*, i.e. the spread between corporate and treasury bonds. Guha and Hiris (2002) empirically demonstrate that this is a counter-cyclical, leading indicator of macroeconomic business conditions. An economic *rationale* for the causality link going from the spread to the business cycle is the credit channel of monetary policy transmission, formalized first by Bernanke and Blinder (1988), and updated by Bernanke and Gertler (1995) and Bernanke,

[18] Researchers such as Cukierman and Gerlagh (2002) and Surico (2002) have performed empirical endeavours along this avenue. See also the references quoted in those papers.

[19] See for example the two stimulating and opposite views by Bernanke and Gertler (2001) and Cecchetti, Genberg, and Wadhwani (2002), and the citations therein. Notice that in their discussion the key variable taken into account as indicator of the financial markets conditions is the asset prices misalignements. Instead, in our empirical exercise we work with the credit spread, as done by Gerlach-Kristen (2002).

Gertler, and Gilchrist (1996).[20]

When considering the EMU, we take up the suggestion in CGG (1998) and Gerlach and Schnabel (2000), and we also add variables such as money (M3) growth, the federal funds rate, and the Euro/US dollar exchange rate. The monetary aggregate M3 was important before the creation of EMU (CGG, 1998) and it is one of the two pillars of ECB's monetary strategy now.[21] The latter two components (federal funds rate, Euro/$ exchange rate) may proxy 'external pressures' affecting Euroland.

Our exercise aims primarily at testing the PA vs. SC hypothesis. To do so, we first estimate equation (8) with the Taylor rate alternatively specified as (4), (5), and (10). As a second step, we estimate the nested model (3), so admitting both the hypotheses, in order to assess if there is room for a 'joint significance'. Given Rudebusch (2002)'s sample choice, we employ the sample 1987Q1-1999Q4 for analyzing the US policy rule. Instead, we consider the time-span 1980Q1-2000Q4 when investigating the EMU area. We adopt a Non Linear Square estimator in models without expectations (i.e. when (4) and (10) are considered), while GMM when (5) is taken into account. Our results and a discussion follow.

5 Findings

We now present our findings. First, we discuss our results relative to the US; then, we pass to the European ones. A comparison between these two sets of results concludes this Section.

[20] In brief, the credit channel works as follows. Suppose to be in a good moment for the economy. Current income is high, and expectations are positive. Then, investors are willing to buy profitable shares; as a consequence, asset prices raise. This improves the situation of the firms' balance sheets, and imply an easier access to banks' loans, on average. The larger collateral available guarantees also more favourable rates on these loans for the firms. As a consequence, firms need to raise less funds via their corporate bonds, then returns on those bonds will be lower. This tightens the credit spread, and triggers (with some lags) the economic boost. However, at some point this boom in economic activities will become inflationary. The CB will react raising the real interest rates, so profits and expectations will turn down. This implies a reduction of the asset prices, so of the collateral that firms may provide to banks. This will induce banks to augment their returns on loans, so firms will have to switch toward other financial channels, e.g. corporate bonds. The increase in the latter's yields will enlarge the credit spread, while the cycle starts declining.

[21] For a discussion on the role of M3 in the ECB's monetary policy strategy, see Masuch, Nicoletti Altimari, Pill, and Rostagno (2002).

5.1 Results on the US

Table 1 collects our findings regarding the PA versus SC test run with US data.[22] A few remarks are worthwhile. First of all, the values and the significance of the parameters b_π and b_y seem to be robust across specifications. In particular, the elasticity of the policy rate with respect to inflation is statistically in line with the value posed by Taylor (1993), with the only exception being represented by the Forward Looking rule.[23] However, also the latter shows a point estimate bigger than one, so confirming the fact that Greenspan's conduct of monetary policy has tended to stabilize inflation volatility. The point-estimates for b_y are slightly larger than the value proposed by Taylor, but are roughly in line with those obtained by Judd and Rudebusch (1998), Kozicki (1999), Amato and Laubach (1999), and Rudebusch (2002). Moreover, the parameter b_z turns out to be statistically significant and having the expected sign. In the first case, this seems to offer a support for the 'asymmetric preferences' conjecture pushed by Cukierman and Gerlach (2002) and Surico (2002); in fact, the negative sign related to the quadratic output gap measure in the Taylor rate indicates an historically *milder* response by the CB when the level of actual output was *over* its potential than when it was *under* it. Our findings just reinforce this conjecture.

As far as the credit spread indicator is concerned, there seems to be a particularly negative reaction of the policy rate to an increase of our risk-indicator. This confirms the 'financial markets influence' put forward by Gerlach-Kristen (2002); indeed, our coefficient is statistically equivalent to that obtained in Gerlach-Kristen's investigation.[24] According to the $\bar{R}^2$

[22] A note of cautious in evaluating our findings is needed. Our econometric estimates rely on the assumption of stationarity of the series at hand. In fact, as far as some of the series employed here are concerned, the null of unit root turns out to be very hard to reject when a standard augmented Dickey-Fuller test is employed. However, it is well known that the Dickey-Fuller test is not very reliable in short sample analyses.

[23] In fact, a standard Wald test cannot reject the restriction $b_\pi = 1.5$ for none of the estimated backward looking Taylor rules. Nevertheless, a bit of cautiousness is necessary here, given the large estimated standard deviations, probably due to the small sample at hand.

[24] Notice that there might be an endogeneity problem here. In fact, variations of the dependent variable (short term interest rate) are likely to influence all the term structure of interest rates, so also the long term rates featuring the regressor (credit spread). We

Taylor rate specification	Standard Taylor	Forward looking	Asymmetric preferences	Credit spread
b_π	1.508^{**} (0.405)	1.146^{**} (0.114)	1.438^{**} (0.330)	1.363^{**} (0.241)
b_y	0.864^{**} (0.195)	1.066^{**} (0.081)	0.696^{**} (0.135)	0.826^{**} (0.075)
b_z	-	-	-0.224^{**} (0.075)	-2.611^{**} (0.531)
γ_2	0.440^{**} (0.167)	0.219^{**} (0.034)	0.332^{**} (0.151)	0.392^{**} (0.071)
γ_3	0.197^{**} (0.070)	0.245^{**} (0.027)	0.301^{**} (0.057)	0.290^{**} (0.073)
$\bar{R}^2$	0.954	0.919	0.965	0.979
$H_0 : \gamma_2 = 1$ (*Wald test, p−value*)	0.002^{**}	0.000^{**}	0.000^{**}	0.000^{**}

*=95%/**=99% rejection of the null hyp. Estimated model:
$\Delta i_t=\gamma_2(b_\pi\Delta f(\bar{\pi}_t)+b_y\Delta g(y_t)+b_z\Delta z_t)+\gamma_3(c+b_\pi f(\bar{\pi}_{t-1})+b_y g(y_{t-1})+b_z z_{t-1}-i_{t-1})+\eta_t$
where $f(\bar{\pi}_t)=E_{t-1}\ \bar{\pi}_{t+4}$,$f(y_t)=E_{t-1}y_t$ in the Forward looking rule; $f(\bar{\pi}_t)=\bar{\pi}_t$,$f(y_t)=y_t$ in the others. $z_t = y_t^2$ (Asymmetric preferences); z_t =spread (Credit spread). Estimates performed via GMM for the forward looking rule; NLS for the backward ones.
Instruments: [c $\bar{\pi}_{t-2}..\bar{\pi}_{t-5}\ y_{t-2}\ ..y_{t-5}\ \Delta i_{t-2}\ ..\Delta i_{t-5}\ \Delta\ \bar{\pi}_{t-2}^{PPI}\ ..\Delta\ \bar{\pi}_{t-5}^{PPI}$],
$\bar{\pi}_t^{PPI}$ four quarter inflation from the Producer Price Index (Finished Goods).
J-test for ov.-ident. restr.($\chi^2(12)$) returned a p-value = 0.78.
NW correction applied to the standard errors (reported in brackets).
c omitted for brevity. $\bar{R}^2$ refers to the *level* of the federal funds rate.

Table 1: Test for PA versus SC: US data

statistic, the descriptive power of all the models employed seems to be high. For our purposes, the most important column of Table 1 is the last one, where we collect all the p-values concerning the Wald test on the null (9). Robustly enough, the null is rejected at the 99% confidence level for all the four cases under investigation, so discarding SC as the unique ex-post descriptive mechanism of the federal funds rate path. This result is in line with ENS (2002)'s findings, and casts some doubts on Rudebusch (2002)'s position.

So far we have run a 'either-or' test. Nevertheless, the policy rate may have been historically determined by *both* PA and SC. Therefore, we also estimate the encompassing model (3) in order to assess if these hypotheses are jointly important from a positive standpoint. Our results are presented in Table 2. First of all, the significance of all the regressors in the Taylor rules is confirmed. Notably, the coefficient b_π is now in line with Taylor (1993)'s assessment also when the Forward Looking specification is employed. Moreover, point-estimates of the parameter b_π are now much closer each other. Also with this encompassing specification, the additional regressor z_t turns out to be quite relevant in fitting the path of the federal funds rate. As far as our key-parameters ρ and ρ_ε are concerned, while estimates of the former suggest that the PA hypothesis is not rejected by the data, much more uncertainty surrounds the latter. Indeed, when the Standard Taylor rate or the Forward Looking one are employed, there is a strong evidence of serial correlation in the estimated residuals. This coefficient is still significant (but not anymore at 99% level of confidence) when we consider the Taylor rule with 'asymmetric' output gap. By contrast, the specification of the Taylor rule with credit spread seems to delete the relevance of the AR(1) model of the error term at the standard 95% level of statistical confidence. Figure 1 shows the remarkable fit obtained with the PA model (3),(10) with credit spread, i.e. a model with $\rho_\varepsilon = 0$. Then, although Rudebusch's position does not seem to acknowledge any possible link between omitted variables in the specification of the Taylor rate and the significance of the SC coefficient ρ_ε,

think that the timing of this feedback still preserves our estimates from the unconsistency threat. Moreover, the estimated sign of the credit spread coefficient turns out to be in line with our expectations. However, we also run 2SLS estimations in order to control for this potential endogeneity. For that, we used the following vector $\underline{z}_t^{'}$ of instruments: $[c \; \Delta\,\bar{\pi}_t \; \Delta y_t \; \Delta spread_{t-1} \; \bar{\pi}_{t-1} \; y_{t-1} \; spread_{t-2} \; i_{t-1}]$. Indeed, also these estimates are clearly in favour of the PA hypothesis.

Taylor rate specification	Standard Taylor	Forward looking	Asymmetric preferences	Credit spread
b_π	1.397^{**} (0.371)	1.379^{**} (0.521)	1.433^{**} (0.265)	1.359^{**} (0.195)
b_y	0.749^{**} (0.209)	0.803^{**} (0.174)	0.677^{**} (0.132)	0.781^{**} (0.091)
b_z	-	-	-0.185^{*} (0.072)	-2.346^{**} (0.512)
ρ	0.609^{**} (0.146)	0.846^{**} (0.037)	0.637^{**} (0.096)	0.618^{**} (0.065)
ρ_ε	0.578^{**} (0.202)	0.438^{**} (0.073)	0.379^{*} (0.175)	0.318 (0.161)
$\bar{R}^2$	0.965	0.937	0.970	0.980

*=95%/**=99% rejection of the null hyp. Estimated model:
$i_t = (1\text{-}\rho)(c+b_\pi f(\bar{\pi}_t)+b_y g(y_t)+b_z z_t)+\rho i_{t-1}+\varepsilon_t,\ \varepsilon_t = \rho_\varepsilon \varepsilon_{t-1} + \eta_t$
where $f(\bar{\pi}_t)=E_{t-1}\ \bar{\pi}_{t+4}$,$f(y_t)=E_{t-1}y_t$ in the Forward looking rule; $f(\bar{\pi}_t)=\bar{\pi}_t$,
$f(y_t)=y_t$ in the others. $z_t = y_t^2$ (Asymmetric preferences); z_t =spread (Credit spread).
Estimates performed via GMM for the forward looking rule; NLS for the backward ones.
Instruments: $[c\ \bar{\pi}_{t-2}..\bar{\pi}_{t-5}\ y_{t-2}\ ..y_{t-5}\ \Delta i_{t-2}\ ..\Delta i_{t-5}\ \Delta\ \bar{\pi}_{t-2}^{PPI}\ ..\Delta\ \bar{\pi}_{t-5}^{PPI}]$,
$\bar{\pi}_t^{PPI}$ four quarter inflation from the Producer Price Index (Finished Goods).
J-test for ov.-ident. restr.($\chi^2(12)$) returned a p-value = 0.91.
NW correction applied to the stand. errors (reported in brackets). c omitted for brevity.

Table 2: Nested PA-SC model: US data

our results point toward that direction.[25]

5.2 Findings for the EMU area

The use on synthetic variables for the EMU area

In analyzing the EMU area, we undertake our empirical exercise by employing synthetic, aggregated indicators. These synthetic measures are constructed as GDP weighted average of the 11 individual countries considered

[25] Rudebusch (2002)'s position about this argument is expressed in his footnote no. 32, page 1182: "Rules 1 and 2 *[i.e. with a Taylor rate respectively like our 'Standard Taylor 'and 'Forward Looking' formulation (our note)]* may appear too parsimonious so that the persistent deviations reflect a serially correlated omitted variable; however, as noted above, the empirical reaction function literature, including monetary VARs, has placed the proverbial kitchen sink on the right-hand side in attempts to explain the policy rate, yet serially correlated errors remain, which are modeled through lagged interest rates and partial adjustment. [...]".

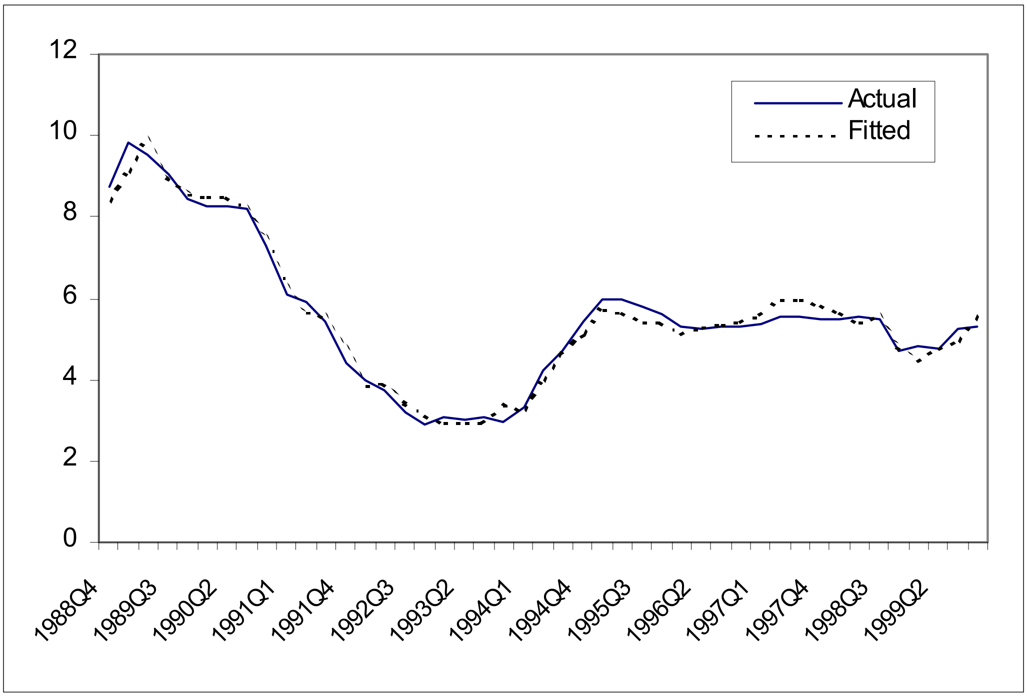

Figure 1: PA model with credit spread for the US

in this analysis.[26] The choice of using aggregated data is due to the will of comparing results obtained for the Euro area as a whole with those for the US; in fact, these two areas look quite similar, at least in terms of economic size and relative importance of external trade (Rudebusch and Svensson, 2002). Moreover, as underlined by Gerdesmeier and Roffia (2003), since the early 80s many European countries have taken a concerted effort to fight inflation. Although some breaks may be clearly identified in this pattern (e.g. ERM crisis in 1992), a common effort to bring down inflation to more sustainable levels has been implemented for long time, and continued with under the monetary policy management by the European Central Bank. Then, the use of synthetic data may be informative on the policy followed by most of the EMU countries in recent years. To some extent, this seems to be a widespread view in recent research; in fact, economic analyses with synthetic data have been performed, among the others, by Taylor (1999), Peersman and Smets (1999), Gerlach and Schnabel (2000), Doménech, Ledo, and Taguas (2002), and Gerdesmeier and Roffia (2003).[27] We think synthetic data may indeed provide us with a rough approximation of a descriptive rule suited for the Euro Area. However, the creation of synthetic data involves the aggregation of different series whose dynamics are somehow heterogeneous. Moreover, the hypothesis is the one of estimating rules followed by a 'fictious' Central Bank. Then, while presenting these results, we acknowledge that the same should be taken with a grain of salt.

EMU area: Results

In analyzing the EMU area, we consider a Taylor rule with and without expectations, and we also investigate for possible asymmetries in the reaction to output gap variations.[28] Moreover, we take into account some proxies for external pressures and domestic concerns that might have had

[26] The countries considered in our analysis are the following: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxemburg, Portugal, Spain, The Netherlands. The definition of the series employed here is proposed in the Data appendix. I thank Barbara Roffia for having provided me with the data.

[27] Taylor (1999) bases his estimates on a weighted GDP and inflation for an aggregate of Germany, France, and Italy, for the sample period 1971Q1-1994Q4. Peersman and Smets (1999) consider synthetic series built upon Germany, France, Austria, Belgium and the Netherlands, for the sample 1975Q1-1997Q4. Doménech, Ledo, and Taguas (2002)'s estimates refer to 11 European countries - the same considered in our analysis - for the sample 1970Q1-1999Q4. Gerlach and Schnabel (2000) consider 10 countries - the same of our analysis but Luxemburg - for the sample 1990Q1-1998Q4. Finally, Gerdesmeier and Roffia (2003) analyze the whole EMU-area for the sample 1985M1-2002M2.

[28] As far as the credit spread is concerned, there has been a developed financial market

an impact on the European monetary policies. In particular, we consider the US $/EURO(ECU) nominal exchange rate and the nominal M3 growth rate.[29]

Our estimates for the Euro area confirm the importance of the PA mechanism in explaining the dynamics of the short term policy rate. Table 3 display the results stemming from the implementation of the ENS test. Notably, the null (9) is strongly rejected with all the different specifications of the Taylor rate considered. Interestingly enough, almost all the point estimates of the inflation coefficient b_π suggest that the European monetary authorities have implemented a fairly tight conduct of the monetary policy during the last two decades. Indeed, all these simple feedback rules find in the output gap measure a significant regressor, so confirming also for the European area the goodness of the Taylor (1993) descriptive scheme.[30]

Interestingly enough, the ENS scheme leads to a robust rejection of the null of SC mechanism also for the European analysis. This result, equal to what obtained for the US, seems to support the conventional wisdom on the monetary policy gradualism.

Table 4 reports some estimates of the nested model (3). Remarkably, the findings reported here suggest that monetary policies implemented in

just for a few years, and mainly in Germany and France. Then, the construction of a measure of credit spread for the Euro area is not straightforward. We ran test-regressions by taking into account the German credit spread (available from 1990 on) and the formerly used US one. None of them turned out to be significant.

[29] The US $/EURO(ECU) exchange rate has been considered in deviations with respect to its sample mean. Apart from the results we present here, we also obtained other figures concerning regressions with addictional variables such as the deviations of the log of M3 with respect to a log-linear trend with drift, the contemporaneous federal funds rate, and the lagged one. None of these addictional variables turned out to be statistically significant.

[30] A consideration has to be made here. If we think about the CB's problem as an optimal control problem featured by a loss function and some constraints representing the economic dynamics, then the coefficient b_y is a convolution of the CB's preferences and the structural parameters of the economy. An estimated positive value for b_y does *not* necessarily suggest a positive weight for the output gap in the CB's loss function; indeed, it might have been important as leading indicator for the future european inflation, as underlined by Peersman and Smets (1999). We recall here that our output gap measure is just a statistical measure, i.e. it is the residual of a regression having the log of GDP as dependent variable, and a constant and a polynomial in time as explanatory variables. For a much more careful estimation of the output gap in the EMU area, undertaken by considering an Unobservable Component model, see Gerlach and Smets (1998).

Taylor rate specification	Standard Taylor	Forward looking	Asymm. prefer.	US $/Euro exch. rate	M3 gr. rate
b_π	1.391** (0.272)	1.925** (0.113)	1.453** (0.319)	1.290** (0.306)	1.013** (0.339)
b_y	0.965** (0.275)	0.755** (0.092)	1.094** (0.490)	1.160** (0.356)	0.792** (0.216)
b_z	-	-	−0.062 (0.195)	−3.398 (2.164)	1.832 (1.176)
γ_2	0.236* (0.094)	0.089 (0.103)	0.210* (0.098)	0.225* (0.101)	0.154* (0.061)
γ_3	0.161* (0.071)	0.272** (0.060)	0.144 (0.072)	0.149* (0.062)	0.206** (0.074)
$\bar{R}^2$	0.976	0.977	0.975	0.976	0.977
$H_0 : \gamma_2 = 1$ ($Wald\ test,\ p-value$)	0.002**	0.000	0.000	0.000	0.000

*=95%/**=99% rejection of the null hyp. Estimated model:
$\Delta i_t=\gamma_2(b_\pi \Delta f(\bar{\pi}_t)+b_y \Delta g(y_t)+b_z \Delta z_t)+\gamma_3(c+b_\pi f(\bar{\pi}_{t-1})+b_y g(y_{t-1})+b_z z_{t-1}-i_{t-1})+\eta_t$
where $f(\bar{\pi}_t)=E_{t-1}\ \bar{\pi}_{t+4}$, $f(y_t)=E_{t-1}y_t$ in the Forward looking rule; $f(\bar{\pi}_t)=\bar{\pi}_t$, $f(y_t)=y_t$ in the others. $z_t = y_t^2$; or z_t=nominal exchange rate in deviations from its sample mean; or z_t=nominal M3 growth rate. Estimates performed via GMM for the forward looking rule; NLS for the backward ones.
Instruments: [c $\bar{\pi}_{t-2}..\bar{\pi}_{t-5}$ y_{t-2} ..y_{t-5} Δi_{t-2} ..Δi_{t-5} $\bar{\pi}^{CPI}_{t-2}$ ..$\bar{\pi}^{CPI}_{t-5}$]; $\bar{\pi}^{CPI}_t$ is the four quarter inflation from the HICP index . J-test for ov.-ident. restr.($\chi^2(11)$) returned a p-value = 0.82. NW correction applied to the stand. errors (in brackets).
c and a spike-dummy (92Q3) omitted for brevity. $\bar{R}^2$ refers to the *level* of the federal funds rate.

Table 3: Test for PA versus SC: EMU data

Europe during the '80s and '90s may be described by a standard Taylor rule with smoothing. In fact, all the addictional regressors considered here turn out to impact the short term policy rate with the right sign, but without owning statistical relevance. Indeed, this is in line with what found by Peersman and Smets (1999) and Gerlach and Schnabel (2000).[31]

Very much like in the previous US analysis, our nested model for Europe tends to confirm the coexistence of PA and SC in determining the policy rate path. A notable exception is represented by the forward looking rule (5). In fact, no trace of SC is detected there. Figure 2 reports the actual vs. fitted policy rate suggested by this rule.

5.3 Robustness check across regions

We briefly review here our empirical findings. First, according to the ENS first-difference model, the presence of the PA component in a positive model for the policy rate seems to be supported by both US and EMU data. Second, there is trace of serial correlation in the policy shocks. However, in the US case this may be due to omitted variables such as the squared output gap (indicator of asymmetric preferences) or the credit spread (leading indicator of the business cycle). When these variables are added to the regression the statistical significance of the coefficient ρ_ε substantially decreases. On the contrary, the role of omitted variable seems not to be central when European data are taken into account. Interestingly, a forward looking Taylor rule à la CGG (1998) turns out to be sufficient for fully taking into account the persistence of the short term policy rate.

Overall, the standard explanatory variables of the Taylor regressions (i.e. inflation and output gap) are robustly significant and with the expected signs and magnitudes (i.e. $b_\pi > 1$, $b_y > 0$) for both the US and EMU.

[31] Instead, these findings seem to be at odds with those in CGG (1998), whose investigated sample spans from 1979 up to 1993. One reason for this different findings may rely on the different data at hand: National in CGG's case, aggregate in ours. Moreover, a plausible explanation for this contrasting result may be the fact that the Maastricht Treaty, signed up in 1992, forced all the signatory countries to implement tight monetary and fiscal policies in order to quickly converge toward the Maastricht criteria. Then, although important, external pressures have necessarily been replaced by domestic concerns, fully captured by our sample choice, while only partially by CGG's.

Taylor rate specification	Standard Taylor	Forward looking	Asymm. prefer.	US $/Euro exch. rate	M3 gr. rate
b_π	1.285** (0.245)	2.039** (0.139)	1.273** (0.253)	1.201** (0.283)	1.113** (0.296)
b_y	0.822* (0.328)	0.743** (0.163)	0.789* (0.376)	0.974* (0.419)	0.789* (0.302)
b_z	-	-	0.023 (0.121)	-3.001 (3.622)	0.897 (0.766)
ρ	0.795** (0.079)	0.755** (0.035)	0.793** (0.082)	0.804** (0.079)	0.793** (0.076)
ρ_ε	0.449** (0.120)	0.233 (0.173)	0.454** (0.125)	0.440** (0.121)	0.424** (0.120)
$\bar{R}^2$	0.980	0.980	0.980	0.980	0.981

*=95%/**=99% rejection of the null hyp. Estimated model:
$i_t = (1\text{-}\rho)(c+b_\pi f(\bar{\pi}_t)+b_y g(y_t)+b_z z_t)+\rho i_{t-1}+\varepsilon_t,\ \varepsilon_t = \rho_\varepsilon \varepsilon_{t-1} + \eta_t$
where $f(\bar{\pi}_t)=E_{t-1}\ \bar{\pi}_{t+4}$,$f(y_t)=E_{t-1}y_t$ in the Forward looking rule; $f(\bar{\pi}_t)=\bar{\pi}_t$,$f(y_t)=y_t$
in the others. $z_t = y_t^2$; or z_t=nominal exchange rate in deviations from its sample mean;
or z_t=nominal M3 growth rate. Estimates performed via GMM for the forward looking rule;
NLS for the backward ones.
Instruments: [c $\bar{\pi}_{t-2}..\bar{\pi}_{t-5}\ y_{t-2}\ ..y_{t-5}\ \Delta i_{t-2}\ ..\Delta i_{t-5}\ \bar{\pi}_{t-2}^{CPI}\ ..\bar{\pi}_{t-5}^{CPI}$]; $\bar{\pi}_t^{CPI}$ is the four
quarter inflation from the HICP index . J-test for ov.-ident. restr.($\chi^2(11)$)
returned a p-value = 0.78. NW correction applied to the stand. errors (in brackets).
c and a spike-dummy (92:Q3) omitted for brevity. $\bar{R}^2$ refers to the federal funds rate *level*.

Table 4: Nested PA-SC model: Euro data

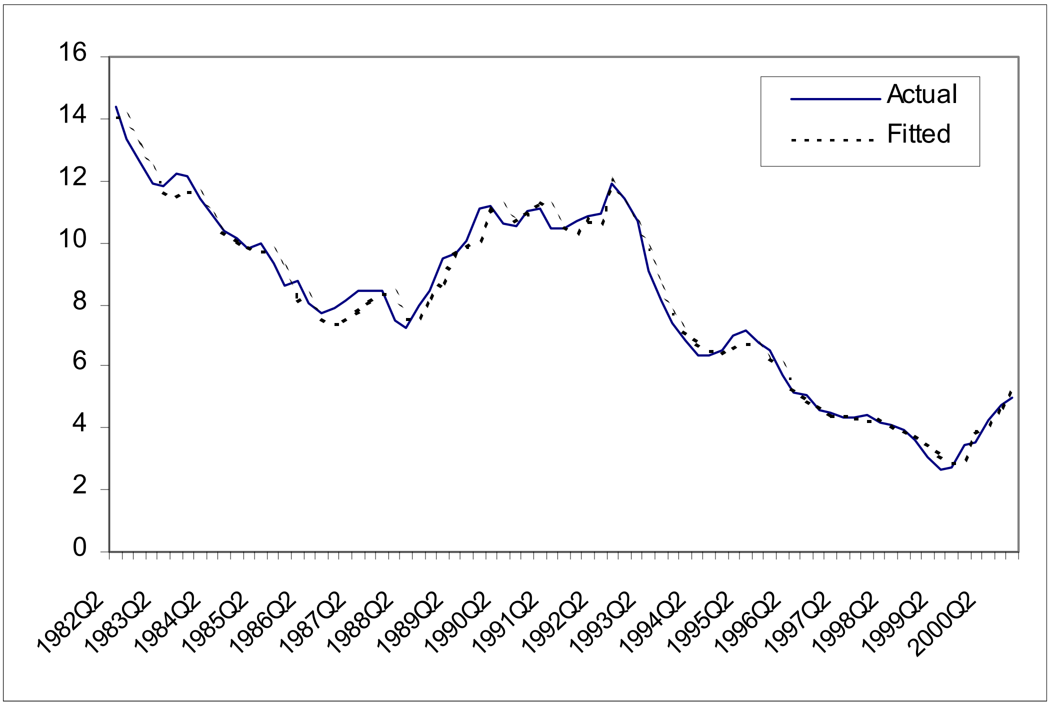

Figure 2: PA forward looking model for the EMU area

6 A note on real time data analyses

In this paper we use revised data; in fact, these data were not available to the Fed or the ECB when they had to take their decisions. What if we used real time data? Lansing (2002) simulates a model in which a CB sets the policy rate without any smoothing, and on the basis of real time estimates of the potential output. In Lansing's study, the measurement error regarding the potential output estimates is serially correlated, because monetary authorities need time to learn about the new potential output process after that a shock has occurred. Lansing discusses how an econometrician who used final, revised data would obtain upward biased estimates of the parameter ρ relative to the true value, because the lagged interest rate captures the omitted, serially correlated, measurement error. Indeed, Lansing (2002)'s conclusions support Rudebusch (2002)'s claim on the massive relative importance of SC versus PA. Mehra (2001) also supports Rudebusch (2002)'s findings. In particular, he works with real time data, and estimates the potential output as a simple log-linear trend of the GDP. His estimates of the partial adjustment coefficient are indeed low, and sometimes even not significant.

Then, are our results misleading? In fact, the impact of real time data on the estimated value of the smoothing parameter is still disputed. Perez (2001) and Orphanides (2001) estimate Taylor rules with real time data, and still obtain high estimated figures regarding the interest rate smoothing coefficients.[32] Moreover, in estimating the nested model (3) we explicitly allow for a serially correlated error term. This choice, not frequently taken in this literature, should enable us to catch the omitted variable effect highlighted by Lansing (2002).

Therefore, from a quantitative point of view, the use of revised data does not necessarily lead to dramatic consequences for our results.[33] Here, we would like to stress the fact that the autoregressive coefficient ρ could indeed have a lower magnitude with respect to the standard assessment of 0.8. However, this does not necessarily imply that the Fed has not smoothed their policy rates; indeed, it could be the case that the sluggishness discussed

[32] Notice that Lansing (2002) and Mehra (2001) focus on the interest rate smoothing value in the policy rule estimation. Instead, Perez (2001)'s paper regards the (non) accommodativeness of the monetary policy in the '70s, while Orphanides (2001) concentrates on the different policy recommendations arising when using revised vs. real time data.

[33] About the smoothing parameter, a similar point is made by Brüggemann and Thornton (2002).

so far in the literature is not so high, but it is still present.

7 Conclusions

In this paper we have focussed our attention on the interest rate smoothing argument in Taylor-type schemes. In a recent contribution, Rudebusch (2002) challenges the conventional wisdom, and state that the interest rate smoothing at quarterly level is just an illusion. As an indirect proof, he claims that if this was not the case, then rational agents should be capable to predict future movements of the policy rate. Indeed, this is not what it happens in reality.

By applying the English, Nelson, and Sack (2002) modeling strategy to the US and EMU, we have estimated the significance of both the interest rate smoothing argument and the serially correlated policy deviations from the Taylor rate prescriptions. This finding, robust across different specifications of the Taylor rate, casts some doubts on Rudebusch (2002)'s claim concerning monetary policy inertia at quarterly frequencies.

An analysis conducted by considering a nested model confirms that the Fed has historically moved the policy rate in a cautions manner. On the contrary, there are some doubts regarding the importance of serially correlated deviations from the Taylor rate in fitting the data. In fact, the statistical significance of the SC mechanism might be spurious and due to omitted variables such as the quadratic output gap or a measure of risk premium. Once one of these two regressors is considered, the serial correlation of the error term turns out to be markedly lower. However, it should be noticed that the introduction of a third regressor in the Taylor rate has a negative impact on the magnitude of the degree of PA. This suggest that the monetary authorities act gradually, but probably respond faster than claimed in the literature to shocks affecting the economy.

About the EMU area, our estimates suggest that a forward looking Taylor rule with interest rate smoothing may very well explain the policy rate path in the '80s and '90s. However, as a general indication it seems to be important to shape the error term as an autoregressive process, in order to take into account potentially serially correlated policy deviations.

Although not definitive, our empirical findings seem to support the search for other important explanatory variables to be included into Taylor type regressions. Asymmetric policy preferences (Cukierman and Gerlach, 2002, and Surico, 2002) and financial indicators (Gerlach-Kristen, 2002) seem to be worth of further investigation both from a positive and from a normative side, also in the light of some recent contributions on asymmetries in the CB's loss function and inflationary bias (Cukierman and Muscatelli, 2002, and Surico, 2003), and on the importance of the financial markets for the monetary authorities (Cecchetti, Genberg, and Wadhwani, 2002).

Colophon

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Data appendix

The variables used in our study have been constructed as follows: π_t is the four-quarter inflation rate computed via the price index (P_t), i.e. $\pi_t \equiv 4(p_t - p_{t-1})$, where $p_t = 100 \ln P_t$. y_t is the output gap, which has been defined as $q_t - q_t^*$, where $q_t \equiv 100lnQ_t$, while $q_t^* \equiv 100lnQ_t^*$. Finally, the upper-barred variables indicate simple averages taken over the contemporaneous observation and the previous three lags of the variable in consideration.

US data description and source

The short term rate used in our analysis is the federal funds rate. The quarterly inflation rate has been computed by using the GDP chain-weighted price index. Our measure of output is the chain weighted real GDP. The potential output series is the one estimated by the Congressional Budget Office. The credit spread has been built as the difference between the Moody's BAA corporate index yield and the 10-year US treasury note yield.

All the series used in this analysis are downloadable from the Federal Reserve Bank of St. Louis web site, i.e. http://research.stlouisfed.org/fred2/.

EMU data description and source

Policy rate: weighted average of euro-11 short-term interest rates. Weights: GDP weights at ppp exchange rates in 2001. National series are from BIS, 3-month money market interest rates (from the Small Green Book) linked to EURIBOR (from Reuters) from 1999 onwards.

$P_t = 100 * QN_t/Q_t, 1995 = 100$, where

$QN_t =$ EU-11 national series on seasonally adjusted nominal GDP ('stocks') at market prices (for more details on sources and methodology for the individual countries data see memo from DG-S (Erikos Velisaratos and Björn Fischer) "Data request: Historical data for the Euro area used in monetary analysis constructed using different aggregation methods") are added after they have been converted to euro via the irrevocable fixed conversion rates of 31 December 1998 (and, in the case of Greece, determined on 19 June 2000). Adjusted for german unification - millions of euro - ESA95 data to the widest extend possible. The quarterly growth rates calculated from this EU-11 GDP series have been used to extend backwards the EU-12 GDP series - available in the ESA95 database - from 2000Q4 back to 1980Q1. The quarterly data are distributed to a monthly frequence (via convert(cubic,end) – interpolation).

$Q_t =$ National series on real GDP ('stocks') at constant prices (for more details on sources and methodology for the individual countries data see memo from DG-S (Erikos Velisaratos and Björn Fischer) "Data request: Historical data for the Euro area used in monetary analysis constructed using different aggregation methods") are added after they have been rebased to a common base year (1995) and converted to euro via the irrevocable fixed conversion rates of 31st December 1998 (and, in the case of Greece, determined on 19 June 2000). Adjusted for german unification. Millions of euro. The quarterly data are distributed to a monthly frequence (via convert(cubic,end) – interpolation).

Q_t^* =Potential output computed as the residual of the regression of $log(Q_t)$ on a constant and a quadratic trend.

US/EURO(ECU) nominal exchange rate: From BIS – code mQK-BAus02. Exchange rate USD/1EURO(ECU), spot at 2.15 PM (CET) M-average.

$M3$: Adjusted stock (millions of euro). The seasonally adjusted index of adjusted stocks from the ECB database is rebased to January 2001 = 100 and multiplied by the seasonally adjusted stock of M3 in January 2001. The percentage change between any two dates (after October 1997) corresponds to the change in the aggregate excluding the effect of reclassifications, other revaluations or exchange variations (and from January 2001 excluding the effect of the enlargement), etc... Adjusted for non-euro area residents' holdings of all negotiable instruments.

All the data series have been provided by the Monetary Policy Strategy Division at the European Central Bank.

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