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No. 56

THE RELEVANCE OF REAL-TIME DATA IN ESTIMATING REACTION FUNCTIONS FOR THE EURO AREA

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Abstract:

This paper tackles the issue of the incompleteness of information available to the central bank when taking its monetary policy decisions. It is focused on euro area data and based on the simplistic assumption of the central bank following a simple monetary policy rule à-la-Taylor. Along the lines of the work by Orphanides (2001), our aim is to assess whether estimates of reaction functions which are carried out using revised data for the euro area can be misleading. In essence, the analysis yields indications which are consistent with the findings by Orphanides for the United States. First of all, the results found suggest that it would be preferable for a central bank not to attach too much weight on output gap measures in policy analysis, given that such measures are subject to large revisions over time. Moreover, the coefficients of a simple Taylor rule estimated *in real time* differ quite considerably from those related to the same rule estimated on the basis of *ex post* revised data. More precisely, a coefficient for inflation larger than one (which is a requirement for a unique equilibrium in many theoretical models) *in real time* is found only in case a forward-looking specification based on the Survey of Professional Forecasters is used. On the contrary, when using *revised* data, the same result is obtained if the Taylor rules include the current inflation rate. This shows how a misleading inference can occur when the appropriate available data are not taken into account.

Key words: Taylor rules; reaction functions; monetary policy; euro area; real-time data

JEL-classification: E58; F41

Contents:

1. Introduction

In the economic literature, increasing attention has been recently devoted to the modelling of the monetary policy decision-making process in the form of simple monetary policy rules.[1] These simple rules à-la-Taylor express the setting of the key interest rate by the monetary authority as the response to a few key variables in the economy, which are usually related to price developments and the real economy situation. This feedback reaction function, therefore, establishes a direct link between a number of selected information variables - deemed to be good indicators of risks to price stability - and the monetary policy instrument.

This type of rules has been regarded as useful in providing a rough benchmark against which developments in the monetary policy instrument of a central bank could be compared. This is because the Taylor rule, while being very simple, seems to be able to capture some of the important elements of the past behaviour of central banks. In particular, such rules can provide a basis for tracking past changes in the central bank's policy instrument, namely the short-term interest rate.

However, such rules are, of course, subject to many caveats, among which the following are worth mentioning.

First, it cannot be assumed that all relevant information needed to conduct monetary policy is encapsulated in current inflation and the output gap. Other variables such as monetary and credit aggregates, private sector expectations, fluctuations in exchange rates, stock valuations, fiscal indicators, variations in international commodity prices and wage agreements may be highly indicative of macroeconomic developments and thus help to interpret the current economic situation.

Second, different sources of shocks call for very different policy responses. The need for monetary policy to react on the occasion of incoming new evidence may depend on whether shocks arise from the supply or demand side of the economy and whether they represent temporary disturbances to an unchanged underlying structure or a lasting alteration of economic parameters. Taylor rules, in restricting the information which trigger policy decisions, are not a reliable guide for policy from this perspective.

[1] We are indebted to A. Orphanides, H.-J. Klöckers, F. Smets, K. Masuch, G. Coenen and S. Nicoletti Altimari for useful comments on earlier drafts.

Therefore, the assumption that the decision-making body of any central bank could base its decisions exclusively on the information content of inflation and the output gap represents a pure simplification.[2]

Besides, the investigations are usually based on revised data which do not take into account the information available in real time. When estimating reaction functions, it should be kept in mind that - in *real time* - data suffer from some shortcomings. As an example, data releases differ across series, thus making some series more incomplete with respect to others - which are more timely available - at each point in time. Moreover, some series are subject to a low degree of accuracy because they are subject to substantial revisions over time. Therefore, *real-time* and *ex post* estimates might differ substantially. Related to this argument, the important problem that the output gap and the equilibrium real interest rate are non-observable variables, should also be noted.

With regard to the specification, two issues are worth mentioning. The first issue relates to the fact that sometimes forecasts-based variants of Taylor rules are considered, so that the inclusion of the output gap in addition to the inflation forecast may reflect an explicit output smoothing objective besides price stability. The second issue refers to the fact that a lagged term of the interest rate is usually included in the Taylor rule, This degree of inertia or smoothing in the policy interest rate generally turns out to be quite high and significant, which might reflect a misspecification of the model (pointing, for instance, to omitted variables which are autocorrelated or to serially correlated shocks).[3]

Furthermore, depending on the estimation methods, the resulting Taylor interest rates may vary over a wide range and thus not provide clear signals.

To sum up, using the words of Orphanides "*[The] historical analysis suggests that the Taylor rule appears to serve as a useful organising device for interpreting past policy decisions and mistakes, but adoption of the Taylor-rule framework for policy analysis is not insurance that past policy mistakes would not have occurred.*"[4]

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[2] In the words of Orphanides (2001) "*… Retrospectively, the 'appropriate' policy setting for a particular quarter may appear different with subsequent renditions of the data necessary to evaluate the rule for that quarter…*", p. 965.

[3] It is worth noting that, as stressed by Ullrich (2003) "…*a reaction function like this is more or less a rule of thumb, there is no consensus for the appropriate specification of the function. So there are a lot of specifications concerning interest rate smoothing and short-run dynamics of the interest rate, backward and forward-looking specifications with respective lags and the determination of the measures of inflation and output gap*…"., p. 3. For a more detailed description of the main caveats related to the use of Taylor rules, see ECB (2001). Among them, the degree of uncertainty around the parameter estimates as well as around the measurement and the set of the variables included in the rule and the sample period considered for the estimation, or the lack of information encapsulated in the few variables usually included in the rule, should be mentioned.

[4] Orphanides (2003), p. 984.

Against this general background, in this paper we are interested in addressing the issue of using *real-time* versus *ex-post* revised data along the lines of the work by Orphanides (2001). The latter finds that *real-time* policy recommendations differ considerably from those obtained with *ex post* revised data. Furthermore, he shows that estimated policy reaction functions based on *ex post* revised data yield misleading descriptions of historical policy, in the sense that different specifications of the rules are suitable to describe US monetary policy over the years 1987-1993. Along these lines, we are interested in analysing how information problems as discussed by Orphanides might also affect the euro area. The study of the magnitude of the informational problems is tackled within the framework of simple monetary policy rules à-la-Taylor.[5]

One obvious caveat of our analysis applied to euro area data is that the span of data available is quite short. In the literature, this problem is sometimes overcome by carrying out the estimations for the period dating earlier than 1999. However, the results would then only refer to the conduct of a fictitious central bank, given that the ECB was only officially responsible for the conduct of monetary policy in the euro area since the start of Stage Three of EMU.

The paper is structured as follows. The following section briefly recalls the basic specification of the monetary policy rules which are used throughout this study. Section 3 reports the estimation results based on *ex post* revised data while in Section 4 we describe the procedures followed to compile the real-time data set and present both a comparison between the *ex post* series and those available in real time and some estimation results using the latter data. Section 5 concludes.

2. Specifications of the monetary policy rules

In the present study we start by considering a Taylor rule with interest rate smoothing, which can be expressed as follows:

(1) $$i_t = (1-r)a + (1-r)bp_t + (1-r)g(y_t - \bar{y}) + r\,i_{t-1} + e_t$$

where i_t represents the policy rate of the central bank, p_t is the inflation rate and $(y_t - \bar{y})$ represents the output gap.[6] This specification of the Taylor rule also contains an interest rate smoothing term. Its inclusion can be justified on the basis that

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5 A number of studies also take additional information from various sources into account, e.g. the information conveyed by monetary aggregates. See e.g. Coenen, Levin and Wieland (2001) and Gerdesmeier and Roffia (2003) on this issue. This topic is left for future analytical work.

6 More detailed information regarding the derivation of this type of rule starting from a simple Taylor rule can be found in Peersman and Smets (1998) and Gerdesmeier and Roffia (2002).

central banks appear to adjust interest rates in a gradual fashion, being adverse to large interest rate movements, thus slowly bringing the interest rate towards its desired setting or “target” level. This smoothing of the interest rate is based on the hypothesis that the current interest rate is determined by weighting the interest rate target of the Taylor rule and the lagged interest rate according to the following:

(2) $$i_t = r i_{t-1} + (1-r) i_t^* + x_t ,$$

where the target interest rate is derived from the standard Taylor rule

(3) $$i_t^* = a + b p_t + g (y_t - \bar{y}) ,$$

and r represents the smoothing parameter. It should be noted that, with an inflation parameter b larger than unity, the rule indicates that the real interest rate would be increased whenever inflation rises, thus exerting a stabilising effect on inflation (the so called "Taylor principle").

The use of this simple specification allows for a direct comparability of our results with those presented by Orphanides, who considered a specification which did not take into account the possibility that the central bank might have reacted to other additional economic variables not contained in the original specification proposed by Taylor. Along the same lines, in order to check for the robustness of the results obtained with the specification in eq.(1), we also consider some slightly modified alternative specifications. On the basis that central banks can only affect inflation with some lags, a forward-looking specification of the following form is estimated:[7]

(4) $$i_t = (1-r)a + (1-r) b E_t p_{t+n} + (1-r) g (y_t - \bar{y}) + r i_{t-1} + e_t ,$$

where p_{t+n} represents the inflation rate forecast (*E* denotes the expected value) at time (*t*+*n*) given the available information at current time *t*.[8] Moreover, the simple rule without interest rate smoothing as originally advocated by Taylor is also used:[9]

[7] During the last 5-6 years, forecasts are argued to have played a powerful role in shaping the response of monetary policy in a way which is not reflected in the simple standard Taylor rule. Therefore, policy rules which do not incorporate such information while historically analysing policy decisions might prove inadequate.

[8] With regard to forward-looking types of reaction functions, other specifications are also possible. For instance, different leads for inflation and the output gap can be employed, or leading inflation and lagging output gap can be inserted in the equation. However, these kinds of forecast-based rules are sometimes criticised because of the inclusion of the output gap in addition to an inflation forecast. In this case, such a rule might appear to reflect two distinct objectives which stands somewhat in contrast with the fact that the primary objective of monetary policy in most industrialised countries rests on the achievement of price stability.

[9] However, there is no consensus about the most appropriate specification of the reaction function. There exist alternative specifications which concern either the inclusion of the interest rate smoothing, or exhibit a backward *versus* forward-looking specifications with different lags and different determination of the measures of inflation and the output gap. For example, Gerdes-

(5) $i_t = a + bp_t + g(y_t - \bar{y}) + m_t$.

3. Estimation of reaction functions using *ex post* revised data

As a first step, this section presents and discusses the results of the estimations of the reaction functions just discussed based *on revised data*. The choice of the data seems worth being discussed in more detail. Inflation is measured as the annual rate of change in the Harmonised Consumer Price Index (HICP).[10] With regard to the output gap, no official or "unique" series seems to exist, and all those available are easily subject to many criticisms. In the literature, different measures have been used, e.g. based on some statistical methods such as fitting a linear or a quadratic trend or using the Hodrick-Prescott (HP) filter. The main International Organisations report some measures of the output gap in real time. In this context, it seems worth noting that the output gaps compiled by the OECD and the IMF are based on a production function method, while the European Commission applies the HP filtering approach. Against this background, in our study we make use of an average of the main output gap measures, namely the linear and quadratic trend measures, the HP Filter and the output gaps provided by the OECD and the European Commission.[11,12]

Consistent with the literature which focuses on the euro area after the start of Stage Three of EMU, the estimations are carried out using the Euro Overnight Index Average (EONIA).[13,14]

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meier and Roffia (2003) investigate whether simple Taylor rules can be improved by considering additional economic variables which were not contained in the original specification proposed by Taylor. However, this type of analysis based on real-time data is left for future research.

[10] The ECB has explicitly announced that, in order to maintain price stability, it aims to maintain the year-on-year increase in the HICP below, but close to, 2% over the medium term. The inflation rate and the output gap are expressed in percentage points.

[11] Given that the data set is monthly, the real GDP and the output gap have been interpolated using a cubic spline.

[12] This - of course - raises the question whether the measures mentioned above have been summed up using an equal weighting. In this study we assume that this is the case but must admit that this does not necessarily have to hold. However, preliminary results show that, when using other measures of the output gap (e.g. single measures or different averages), the qualitative results generally hold. These cross-check results are available from the authors upon request.

[13] In the literature the Euro Overnight Index Average (EONIA) is used for the estimations because it is the market rate which is more closely influenced by the monetary policy of the ECB. Moreover, this rate is also close to the Federal Funds rate which is commonly used for the United States.

[14] In this respect, the choice of the rate on main refinancing operations was seen as unsatisfactory due to estimation problems related to its step-like behaviour. Moreover, the choice of the 3-month money market interest rate has also been thought as being not convincing as it could be argued that, in some cases, the three-month money market interest rate might reflect market's anticipations of the future moves of policy rates in reaction to currently available data.

With regard to the estimation technique and the diagnostic tests, in line with the literature the Generalised Method of Moments (GMM) is used. This technique nests many common estimators and is chosen in order to avoid a possible correlation between the right-hand variables and the residuals (so-called simultaneity bias). This is done by making use of appropriate instruments. Generally speaking, the set of instruments should contain variables known to the central bank at the time it sets the interest rate that are orthogonal to the residual term. In this context, lagged values of the explanatory variables appear to be the natural candidates. The set of instruments used is specified at the end of each table. Following Gerdesmeier and Roffia (2003), the weighting matrix is chosen using the method suggested by Newey and West (1987), who have proposed a general covariance estimator that is consistent in the presence of both heteroskedasticity and autocorrelation of unknown form (so-called *HAC Covariances*).[15] It should be noted that GMM requires no information about the exact distribution of the error term which implies that the normality assumption – being a crucial precondition for many other estimation procedures – is not required. All that is required is that the orthogonality conditions hold. We also checked the *J-statistic* which is used to test the validity of overidentifying restrictions (i.e. when the number of instruments is greater than the number of parameters to be estimated).[16] The results of this test are consistent throughout all the specifications and indicate that the overidentifying restrictions are satisfied. Finally, all the estimates, unless differently specified, are carried out using data spanning the sample period 1999:01 – 2003:06, with the starting date being the start of Stage Three of EMU when the ECB started to conduct its monetary policy for the euro area.[17]

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[15] See Gerdesmeier and Roffia (2003) for a discussion on the adoption of the GMM instead of the OLS methodology, as well as of the choice related to the instruments and the use of the Newey-West HAC consistent covariance.

[16] Under the null hypothesis that the overidentifying restrictions are satisfied, the J-statistic times the number of regression observations is asymptotically c^2 distributed with degrees of freedom equal to the number of overidentifying restrictions. For further detail, see Johnston and DiNardo (1997) p. 337 *ff*.

[17] In some cases, the end of the sample may differ according to the availability of some series.

Table 1

Estimates of Taylor rules in the euro area using *ex post* revised data

Specification	a (1)	r (2)	b (3)	g (4)	$\bar{R}^2$
Simple TR without smoothing (1)	1.93 (0.04)	(-)	0.80 (0.02)	0.72 (0.01)	0.82
Simple TR (1)	1.22 (0.04)	0.84 (0.01)	1.08 (0.02)	0.70 (0.02)	0.95
Forward-looking (*t+12*) (2)	1.74 (0.35)	0.86 (0.01)	0.61 (0.16)	2.41 (0.08)	0.96

Notes

a. TR denotes Taylor Rule.

b. Sample period 1999:01-2003:03.

c. Instrument list of the equations in the table:
(1) 1-6,9 and 12 lags of the inflation rate, output gap, unemployment rate and annual changes in the DJ EuroStoxx and in the euro/US $ exchange rate.
(2) 1-6,9 and 12 lags of the inflation rate, output gap and annual changes in oil prices.

d. In eq.(3) in the table above perfect foresight is assumed.

e. Standard errors in parenthesis.

Looking at the figures reported in the table above, the following results are worth mentioning.

First, the results show that in case a simple Taylor rule specification is used, the ECB seems to have reacted to inflation with a coefficient higher than one which, in the literature, is generally interpreted as denoting a stabilising behaviour.[18] The opposite seems to hold in the case of a forward-looking specification. Moreover, the weight placed on the output gap has a considerably smaller size for a contemporaneous specification of the rule while being very large for a forward-looking rule.

[18] On the contrary, Ullrich (2003) observes a structural break between pre-1999 and post-1999 monetary policy in the euro area and finds that the ECB does not comply with the Taylor principle. A similar result is obtained by Sauer and Sturm (2003) when using *ex post* data who apply the HP filter to industrial production in order to calculate the output gap.

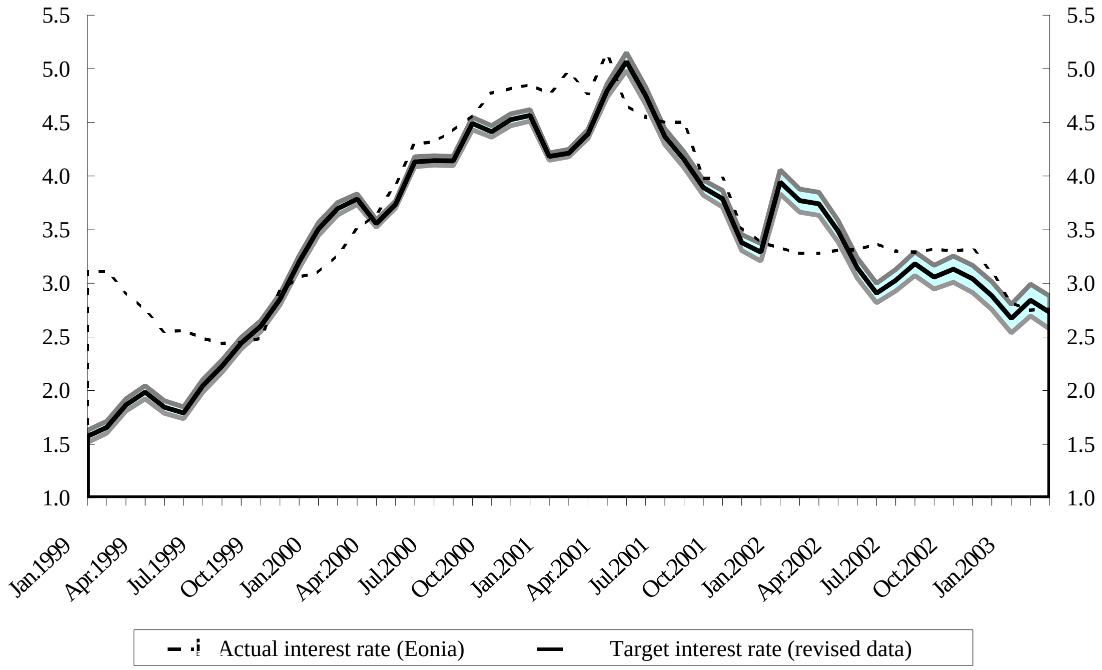
Second, estimating the original specification by Taylor (i.e. without an interest rate smoothing) seems to lead to a deterioration of the fit of the equation.

Third, in the specifications containing the smoothing parameter, the degree of i-nertia appears to be quite high. This phenomenon has been discussed extensively in the literature and seems to be a common result for central bank reaction functi-ons.

In Figure 1 below we report – as a shaded area – the lower and the upper bounds for the policy recommendations related to the estimated simple Taylor rule with smoothing. These uncertainty bands represent a measure of the parameter un-certainty (in this specific case of inflation and the output gap coefficients) and are calculated as follows.[19] The first one is derived using the coefficient on inflation and the one of the output gap which are, respectively, at the higher and at the lo-wer bound of the confidence band of two standard errors while the other one in which these coefficients are, respectively, at the lower and at the higher bounds. The thick black line represents the target interest rate which is calculated applying eq.(3) in the text using the estimated coefficients, while the dotted line represents the actual EONIA. The uncertainty bands turn out to be rather narrow, and at the end of the sample the target and the actual interest rates almost coincide.

[19] Therefore, our method of calculating the uncertainty bands neglects the uncertainty surrounding the real equilibrium interest rate.

Figure 1
Range of uncertainty regarding policy recommendations – *ex-post* revised data



4. The use of the real-time data: a comparison with the *ex- post* revised data

This section in essence presents an investigation of Taylor rules for the euro area estimated in real time. We first provide a description of the method employed to construct these series and then we examine the magnitude of the revisions in the data over time and the main implications for the key variables resulting from the different methodologies employed to reconstruct the data. In the next sub-section we then present the estimates obtained with the real-time data and compare the outcomes with those derived using revised data. The final sub-section summarises the main conclusions of the exercise.[20]

[20] A detailed description of the series used is contained in Annex A.

4.1 The construction of the real-time databases

As explained in more detail in Orphanides (2001), specifying a contemporaneous Taylor-like rule implies accurate and timely time series for inflation and the output gap. However, it is well known that this assumption is not fulfilled in practice due to the following facts:

Variables (in particular the series for output) are only available with some lags. This reflects the well-known problem of the end-of-sample mismatch, where some data usually become available with some periods lags.

In many cases, variables are not only available with some lags but even with different delays, so that the update differs across the series.[21] Therefore, as a consequence at a certain point in time the data set available to the policy maker can still be incomplete because of the different timing of the data releases.

Data are subject to revisions and it may take some quarters before accurate data are available for some series.[22]

Therefore, relying on *ex post* revised data, more knowledge is assumed about the state of the economy which the central bank did not have when taking its decisions.

Against this background, in this study, we consider different data sets. The first one is a monthly real-time database which has been updated using the information on the series as they were made available in the ECB Monthly Bulletin since 1999. These data, therefore, may be seen as an attempt to provide parts of the information available to the ECB in real time for the first meeting of each month (these data will be denoted as RT_1 henceforth).[23]

The assumption of the decision-making body of the ECB reacting only to a small sub-set of variables reflecting the current conditions is, however, clearly unrealistic. In this respect, the advantage of using forecasts of inflation is that they summarise more information than the actual available series (as the forecast reflects additional information/variables and the effects on inflation). Therefore, we make use of a second data set which includes inflation forecasts related to the Survey of Professional Forecasters (SPF). We will denote these data set as RT_2

[21] This is usually denoted as "unbalanced" set of data, where series ends in different periods.

[22] Coenen and Wieland (2001) analyse the timing and magnitude of the revisions in the euro area main economic variables. They argue that the magnitude of the revisions is quite big, which suggests a significant degree of data uncertainty, which persisted for some time over the years since 1999.

[23] See, for instance, Coenen, Levin and Wieland (2001), p. 11.

henceforth. In the following sub-sections we illustrate the real-time data sets which have been compiled on the basis of different criteria which are discussed below.[24]

4.1.1 Latest available data

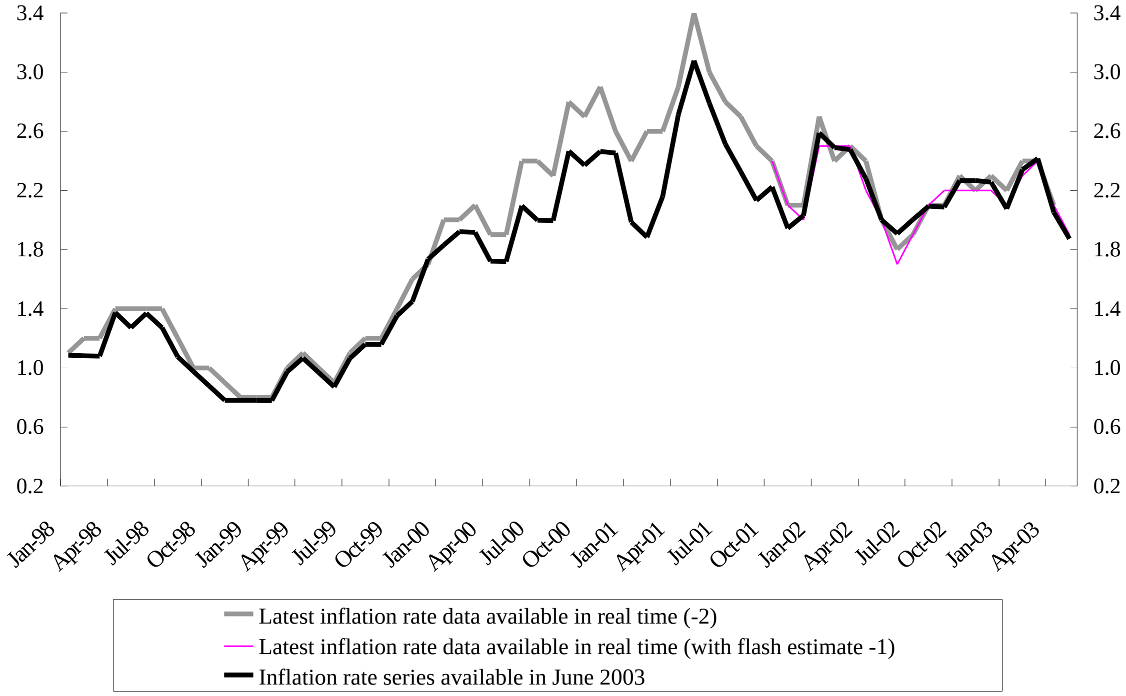
One way to overcome the problem of availability of data with some lags is to assume that the policy maker reacts to the latest available "current" information about a series. According to this, we consider real-time data which are compiled by considering, at each point in time, the latest available information which was at disposal of the ECB for each of the key variables. Of course, given that the timeliness of the series differs across the variables, their values considered at time *t* refer to past observations.[25]

Figure 2 below shows a comparison of this type of real-time data for inflation with the corresponding revised series. In order to facilitate the interpretation, the chart includes three time series. The first series shows the inflation rate which was available in June 2003 (i.e. the *ex post* revised data).[26] The second series is the latest inflation rate data available in real time. In order to make it comparable to the previous series, we have shifted it backwards by two months on the basis that - on average - the real-time inflation values are available with a period of two-month's lags.[27] The third series is the latest inflation rate data available in real time which includes Eurostat's flash estimate (and, on the basis of the approach for the previous series, it is only lagged by one month).[28]

[24] The cut-off date for this exercise is end of June 2003.
[25] As an example, while at the beginning of June the observation for inflation is likely to refer to the April observation, the one for real GDP are likely refer to the first quarter of the year.
[26] Coenen and Wieland (2001) show that both monthly and quarterly data yield remarkably similar conclusions regarding real-time data uncertainty in the euro area, thus suggesting that the frequency is not a major issue when assessing the size of the revisions in the data.
[27] This is based on considering the beginning of the month as the cut-off date.
[28] This series is, however, only available from November 2001 onwards.

Figure 2

Comparison of *real time* versus *ex-post* revised data – non-seasonally adjusted inflation rate (Eurostat source)



The figure allows to draw a number of interesting conclusions. First, the real-time inflation rate lies above the revised series (apart from some few observations). Second, in some periods, considerable differences in the series can be detected, part of which can be due to the recent revisions which occurred in January and March 2003.[29] Third, at the actual end, these differences seem to have disappeared, thus possibly denoting a higher precision in the first release of the data. Figure 3 below provides a similar comparison using seasonally adjusted data as they have been compiled by the ECB since January 2001.[30] Also in this case, some revisions in the data can be noticed which tend to disappear towards the end of the sample considered.[31]

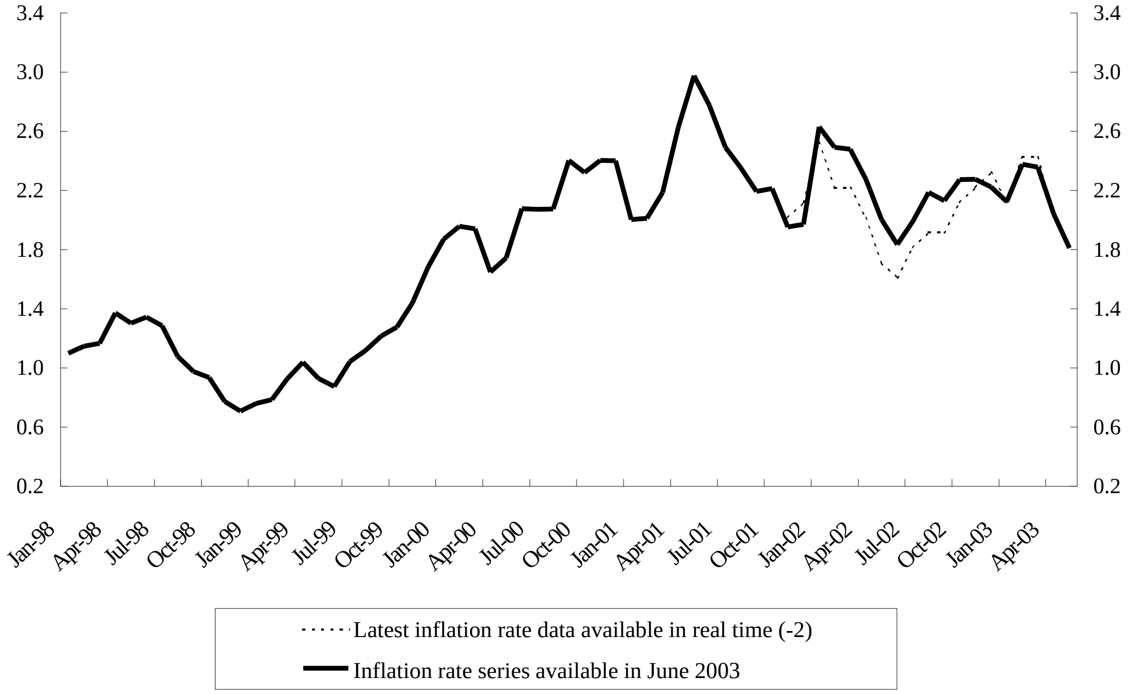
[29] These revisions were mainly due to revisions to the German HICP as a result of the introduction of the new base year 2000, but also due to some methodological changes. In addition to this, also the country and product weights in the euro area HICP have been updated.

[30] In this case, the series based on the flash estimates is missing.

[31] Coenen and Wieland (2001) argue that "…*the consumer price data are typically not revised at all; the only exceptions are apparently due to corrections of reporting errors*…", p. 13.

Figure 3

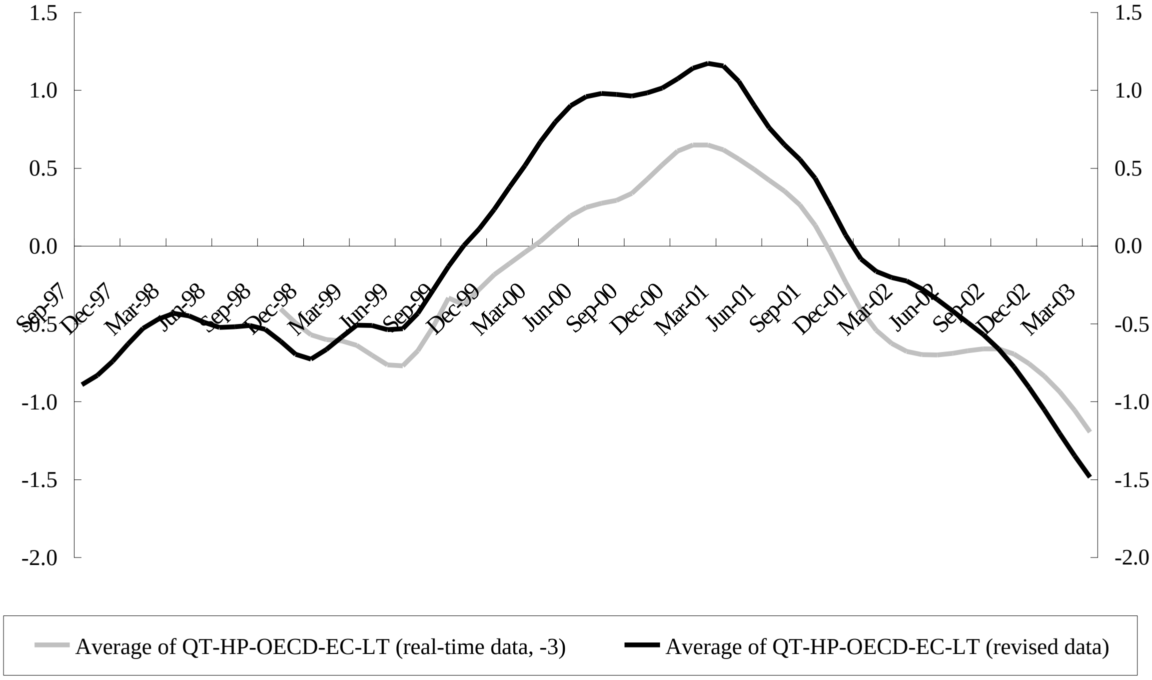
Comparison of *real-time* versus *ex-post* revised data – seasonally adjusted inflation rate (ECB source)



In the figure below we report a comparison for the output gap. For this variable, real-time estimates tend to under-predict the realised output gap since 1999.[32]

[32] Consistently with our results, Coenen and Wieland (2001) report that real GDP is subject to fairly large revisions, although these revisions are likely to become smaller as the implementation process to ESA95 is completed in most countries. On the contrary, revisions of the GDP deflator appear to be much smaller.

Figure 4
Comparison of *real-time* versus *ex-post* revised data for the output gap

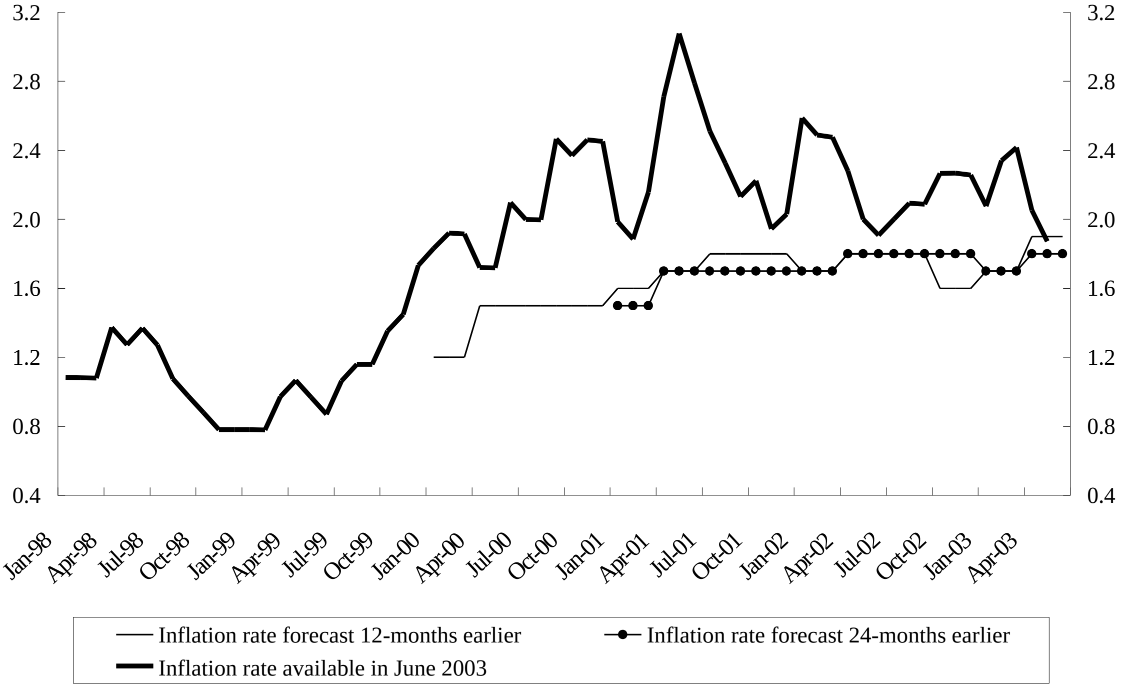


4.1.2 Forward-looking specifications in real time using SPF inflation forecasts series

We have constructed data sets which include, for inflation, forecasts either referring to the next calendar year or two years ahead - which were available at that time - are used. For this purpose, we use a set of forecasts which are taken from the Survey of Professional Forecasters (i.e. SPF), which is a survey of expectations for the rates of inflation, real GDP growth and unemployment in the euro area for several horizons which is done on a quarterly frequency (see Annex A for additional details). With regard to the output gap, we use the data described in Section 4.1.1. The resulting specification of the reaction function is, therefore, forward-looking over the forecast horizons of n =12 and n = 24 (see eq.(2) above).

The figure below reports the *ex post* revised inflation rates versus the inflation rates which had been forecast 12 and 24 months earlier using the SPF. The time patterns show that the inflation forecasts always underestimated realised inflation.

Figure 5
Actual versus forecast inflation rates from the SPF at different horizons



4.1.3 Summary statistics on differences in real-time versus ex-post data

The table below illustrates a summary of some statistics which allow comparing the revised data with the real-time series described in Sections 4.1.1 and 4.1.2 above. From these statistics it can be inferred that, with regard to inflation, the mean, the median and the standard deviation tend to be lower when using inflation forecasts (with the former two being lower at the *t+12* forecast horizon).[33] Moreover, for the same series the range of possible values is much narrower. The opposite result holds instead when using the *ex-post* revised series which tends to exhibit a much higher mean and standard deviation and a larger range of values. When looking at the output gap, it is worth noting that the same results hold: the fact that the mean in real time is lower would denote an underestimation – on average – of the series. Furthermore, the figures indicate that the revisions in this series are also very large and persistent.[34] Also the standard deviation turns out to be lower in real time.

[33] For the revised data, perfect foresight is assumed.
[34] This finding is very similar to the one in Orphanides (2001), whose results also suggested a lack of reliability in the real-time estimates of the output gap.

Table 2

Summary statistics

	Mean	MA	Median	St. dev.	Min.	Max.
Inflation available in June 2003	1.95	1.95	2.07	0.54	0.76	2.98
Inflation available in real time	2.05	2.05	2.15	0.66	0.80	3.40
Inflation available with (t+12) SPF forecasts	1.66	1.66	1.70	0.17	1.20	1.90
Inflation available with (t+24) SPF forecasts	1.76	1.76	1.80	0.09	1.50	1.90
Output gap available in June 2003	0.09	0.65	0.00	0.75	-1.48	1.17
Output gap available in real time	-0.24	0.51	-0.39	0.52	-1.19	0.65

Note
MA denotes the mean of absolute values.

4.2 Estimation of reaction functions using real-time data

This Section focuses on the estimates of reaction functions for the euro area using the real-time data sets presented in 4.1.1- 4.1.2. The analysis is focused on estimating simple Taylor rules with and without smoothing.

4.2.1 Using the latest available data

Table 3

Estimates of Taylor rules in the euro area, real-time latest available data (i.e. RT_1)

	Specification	a (1)	r (2)	b (3)	g (4)	$\bar{R}^2$
1.	Simple TR without smoothing	3.15 (0.06)	(-)	0.25 (0.03)	1.20 (0.03)	0.81
2.	Simple TR	3.40 (0.09)	0.63 (0.03)	0.39 (0.05)	2.05 (0.08)	0.88

Notes
a. TR denotes Taylor Rule.
b. Sample period 1999:01-2003:06.
c. Instrument list of the equations in the table: 1-6, 9 and 12 lags of annual changes in the DJ EuroStoxx, in the oil prices and in the euro/US $ exchange rate.
d. Standard errors in parenthesis.

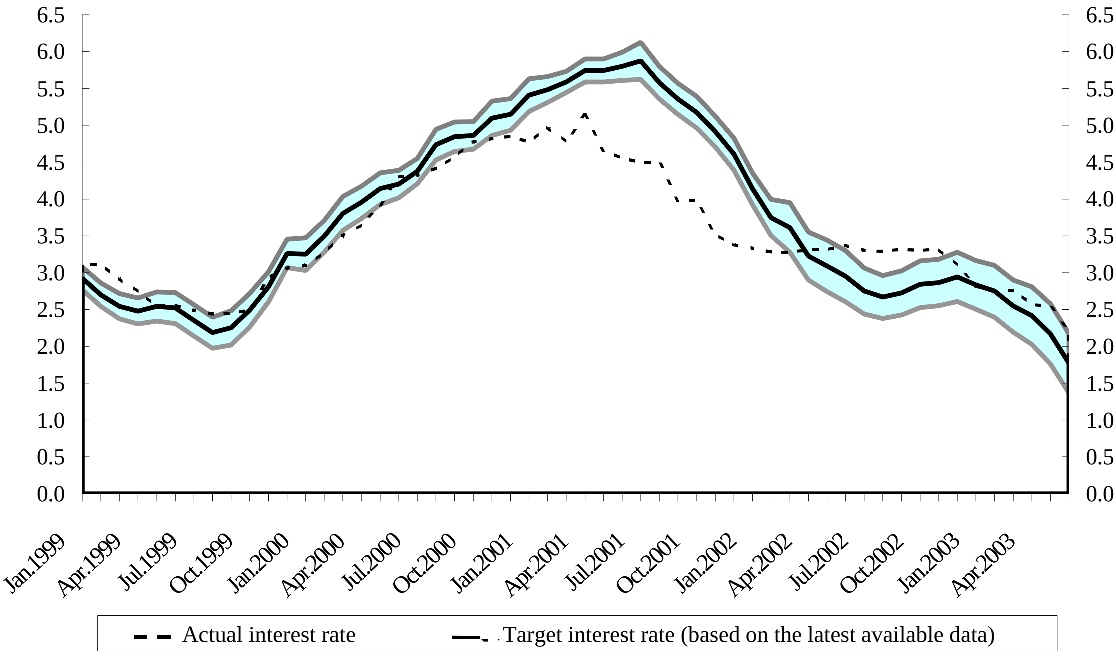
While some of the results seem to be broadly comparable, some striking different results emerge. First, using a contemporaneous simple Taylor rule in real time can obviously result in an inflation coefficient lower than one. However, a possible intuitive explanation might be that the central bank chose not to over-react to the sequence of one-off shocks which occurred to euro area inflation. This notwithstanding, this result is in contrast with the outcome using revised data according to which the inflation coefficient was significantly higher than one.[35] Second, the standard errors of the coefficients are higher, thus leading to more imprecise estimates. The fit does not seem to be much very affected when using real-time data, although being slightly lower.

In Figure 6 below we report the lower and the upper boundaries for the policy recommendations related to the estimated simple Taylor rule with smoothing in real time as we did in Figure 1 above. In contrast to the equivalent graph based on revised data, it can be noticed that, in real time, the uncertainty bands are slightly larger and, therefore, more ambiguity lies in the monetary policy assessment.

[35] Sauer and Sturm (2003) carry out a similar exercise and they find that the use of real-time industrial production worsens the ability to describe ECB's monetary policy with a Taylor rule. Moreover, the inflation parameter remains below one.

Figure 6

Range of uncertainty regarding policy recommendations – real-time last available data (i.e. RT_1)



4.2.2 Using the forward-looking specification based on the SPF inflation forecasts series

In order to take into account that a central bank faces long (and variable) lags characterising the transmission process and uses a broader range of information, the estimates in the table below are based on a forward-looking specification of the Taylor rule, where the inflation forecasts are modelled via the SPF inflation forecasts for one and two years ahead. The real GDP data are those used in the section above.[36]

[36] Inflation and real GDP are not included among the set of Instrumental Variables because of the method used to construct the series, i.e. spline of annual data into monthly data.

Table 4

Estimates of Taylor rules in the euro area, real-time SPF forecasts for inflation (i.e. RT_2 data)

	Specification	a (1)	r (2)	b (3)	g (4)	$\bar{R}^2$
3.	Simple TR (*t+12*)	1.87 (0.46)	0.71 (0.04)	1.31 (0.27)	1.95 (0.13)	0.93
4.	Simple TR (*t+24*)	-0.84 (0.43)	0.67 (0.03)	2.91 (0.24)	2.02 (0.07)	0.90

Notes
a. TR denotes Taylor Rule.
b. Sample period 1999:01-2003:06.
c. Instrument list of the equations in the table: 1-6, 9 and 12 lags of annual changes in the DJ EuroStoxx, in the euro/US $ exchange rate and in the oil prices.
d. Standard errors in parenthesis.

From this table a number of interesting results emerge. In comparison with the results obtained using real-time data in a contemporaneous (at time *t*) specification and presented in Table 3, a Taylor rule using a forward-looking specification (and smoothing) yields values for b higher than one, thus denoting a stabilising policy in real time.[37]

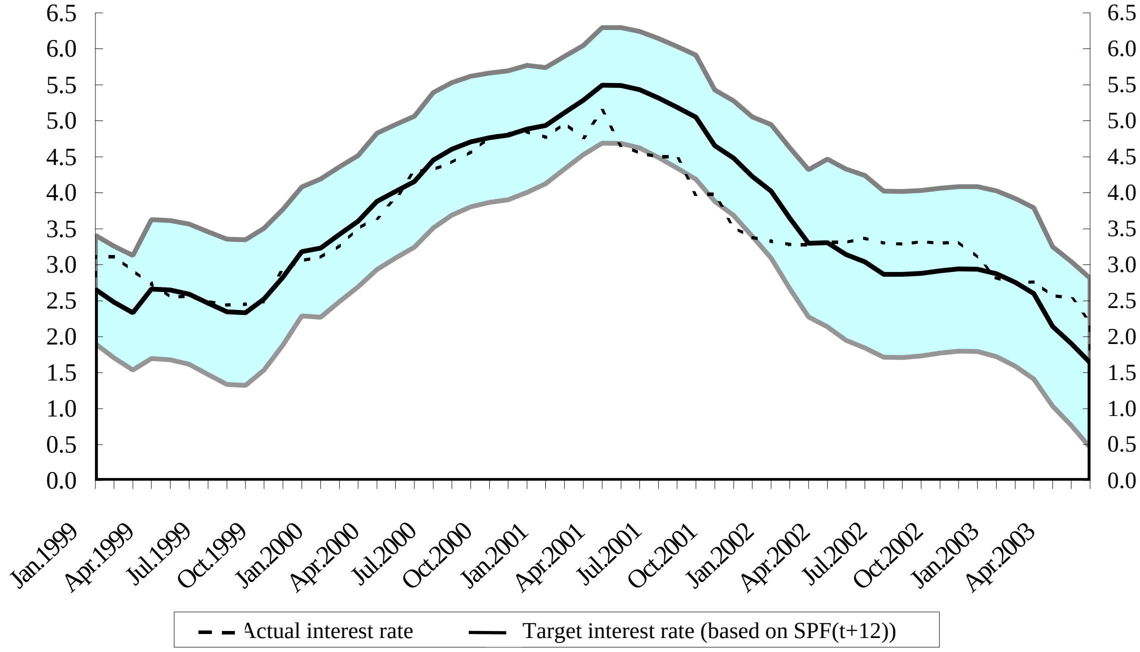
Furthermore, when comparing the latter results with the forward-looking specification based on *ex post* revised data, the most notable difference consists in the fact that the response to the output gap in real time seems to have been lower than the one estimated using revised data. The opposite result instead holds for inflation.

As it was done for the *ex post* and the first real-time data set considered above, we also provide the uncertainty range of the policy recommendations based on the 12-months ahead forward-looking specification based on the SPF inflation forecasts. The uncertainty bands turn out to be quite wide

[37] Sauer and Sturm (2003) obtain a similar result using inflation forecasts published by The Economist but only when policy inertia is not taken into account in the estimations.

Figure 7

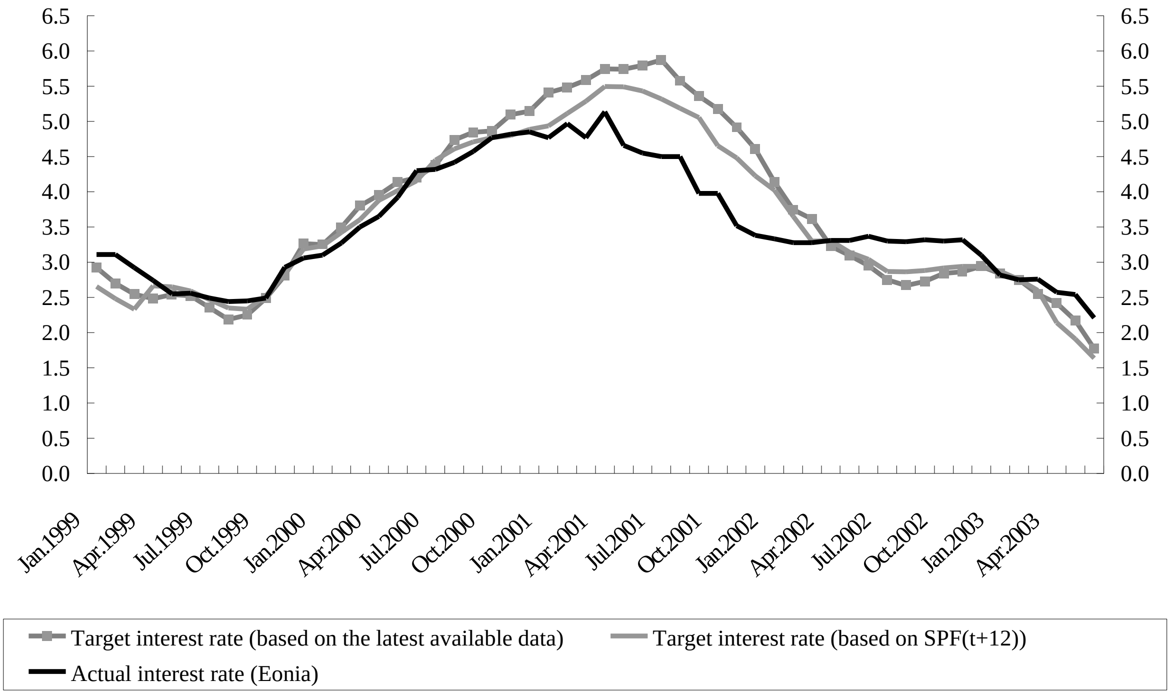
Range of uncertainty regarding policy recommendations using SPF forecasts for 12-months ahead



In the table below we show the different target interest rates which are calculated using the best specifications of the Taylor rule with smoothing. These target rates refer to the different type of data set considered in the analysis in Sections 3 and 4. More precisely, they include the rate based on the revised data and with a contemporaneous specification and the ones derived from the forward-looking specification based on the SPF forecasts for inflation.

Figure 8

Target interest rates for the euro area



5. Conclusions

This paper has investigated whether relying on *ex-post* revised data when estimating reaction functions for the euro area can lead to different conclusions from those which would have been advocated using data available in real time. The analysis has yielded the following results.

First, when using revised data and a contemporaneous specification of the rule, the coefficient on inflation turns out to be higher than one, thus denoting a stabilising policy, while the coefficient on the output gap is somewhat lower. On the contrary, when Taylor rules based on the contemporaneous values for inflation and the output gap are estimated in real time, the outcome is that the Taylor principle is not satisfied. A possible explanation of this outcome might be that the response of the central bank has appropriately taken into account the sequence of one-off shocks characterising inflation in the euro area over the last years.

Second, in real time forward-looking specifications of the Taylor rule using the SPF forecasts provide a better description of the actual behaviour of the central bank and also denote a stabilising behaviour. This results supports the argument which was put forward by Orphanides who had found for the United States that a forward-looking specification would have tracked better the interest rate in real time while a contemporaneous one would work better for the revised data.

Third, the uncertainty bands surrounding the target interest rate calculated in real time are somewhat wider than those referring to *ex post* data.

Of course, many interesting aspects have remained untouched in the analysis which could be worth pursuing. Among them, the analysis of the impact of the estimation error in the output gap on the Taylor rule interest rate and the investigation whether the incorporation of additional variables in the feed-back list may help to track better the monetary policy decision-making process.

References

Alesina, A.F., O.J. Blanchard, J. Galí, F. Giavazzi and H. Uhlig (2001), “Defining a macroeconomic framework for the euro area – No. 3”, *CEPR,* London

Bernanke, B. and I. Mihov (1995), “Measuring monetary policy”, *NBER Working Paper*, No. 5145

Brand, C., D. Gerdesmeier and B. Roffia (2002), “Estimating the M3 income velocity underlying the reference value for monetary growth”, *ECB Occasional Paper*, No. 3

Brown, R.L., J. Durbin and J.M. Evans (1975), "Techniques for testing the constancy of regression relationships over time", *Journal of the Royal Statistical Society*, Series B, Vol. 37, pp. 149-192

Chow, G. and A. Lin (1971), “Best linear unbiased interpolation, distribution and extrapolation of time series by related series”, *The Review of Economic and Statistics*, Vol. 53, No.4, pp. 372-375

Clarida, R., J. Galí and M. Gertler (1998), “Monetary policy rules in practice. Some international evidence”, *European Economic Review*, Vol. 42, pp. 1033-1067

Coenen, G., A. Levin and V. Wieland (2001), “Data uncertainty and the role of money as an information variable for monetary policy”, *ECB Working Paper*, No. 84, forthcoming in the *European Economic Review*

Deutsche Bundesbank Monthly Report “Taylor interest rate and Monetary Conditions Index”, April 1999

ECB (2001), “Issues related to monetary policy rules”, *ECB Monthly Bulletin*, October 2001

Faust, J, J.H. Rogers and J.H. Wright (2001), “An empirical comparison of Bundesbank and ECB monetary policy rules”, *Board of Governors of the Federal Reserve System, International Finance Discussion Papers*, No. 705

Favero, C. A. (2001), Applied Macroeconometrics, Oxford University Press

Galí, J. (2001), “Monetary policy in the early years of EMU”, *Pompeu Fabra University,* mimeo

Gerdesmeier, D. and B. Roffia (2003), "Empirical estimates of reaction functions for the euro area", *ECB Working Paper*, No. 206

Gerlach, S. and G. Schnabel (1999), “The Taylor rule and interest rates in the EMU area: a note”, *BIS Working Paper*, No. 73

Gerlach, S and L.E.O. Svensson (2001), “Money and inflation in the euro area: a case for monetary indicators?”, *Bank for International Settlement Working Paper*, No. 98, also published in the *Journal of Monetary Economics*, Vol. 50 (2003), pp. 1649-1672Granger, C.W.J. (1986), “Developments in the study of cointegrated economic variables”*, Oxford Bulletin of Economics and Statistics,* Vol. 48, pp. 213-228

Hamilton, J.D. (1994), “Time series analysis”, Princeton University Press

Hansen, L. (1982), "Large sample properties of generalised method of moments estimators", *Econometrica*, Vol. 50, pp. 1029-1054

Harvey, A. (1990), “Forecasting, structural time series models and the Kalman filter”, Cambridge University Press.

Johnston, J. and J. DiNardo (1997), "Econometric methods", McGraw-Hill, 4th ed.

Judd, J.P. and G.D. Rudebusch (1998), “Taylor’s rule and the Fed: 1970-1997”, *Federal Reserve Bank of San Francisco Economic Review*, No. 3, pp. 3-16

Newey, W. and K. West (1987) "A simple, positive definite, heteroskedasticity and autocorrelation consistent covariance matrix", *Econometrica*, Vol. 55, No. 3, pp. 703-708

Orphanides, A. (1998), “Monetary Policy Evaluation with Noisy Information”, *Finance and Economics Discussion Series Working Paper*, No. 1998-50, Board of Governors of the Federal Reserve System

Orphanides, A. (2001), "Monetary policy rules based on real-time data", *The American Economic Review,* Vol. 91, No. 4, pp. 964-985

Orphanides, A. (2003), “Historical monetary policy analysis and the Taylor rule”, *Journal of Monetary Economics*, Vol. 50, pp. 983-1022

Orphanides, A. and van Norden, S. (2001), “The unreliability of output gap estimates in real time”, *CIRANO Working Papers*

Peersman, G. and F. Smets (1998), “Uncertainty and the Taylor rule in a simple model of the euro area economy”, mimeo

Rudebusch, G. (2002), “Term structure evidence on interest-rate smoothing and monetary policy inertia”, Vol. 49, pp. 1161-1187

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

Taylor, J.B. (1993), “Discretion versus policy rules in practice”, *Carnegie-Rochester Conference Series on Public Policy*, Vol. 39, pp. 195-214

Ullrich, K. (2003), “A comparison between the Fed and the ECB: Taylor rules”, *ZEW Discussion Paper*, No. 03-19

Woodford, M. (1999), “Optimal Monetary Policy Inertia”, *NBER Working Paper*, No. 7261

Woodford, M. (2003), "Interest and Prices: Foundations of a Theory of Monetary Policy", Princeton University Press

Annex A. Description of the data

The historical series used in the estimation of the reaction functions refer to the euro area (i.e. the euro area-11 for months up to December 2000, and the euro area-12 from January 2001 onwards). Whenever applicable (e.g. interest rate, exchange rate, DJ Euro Stoxx), monthly data are calculated as average of daily data.

A.1 Revised data

Interest rate: the overnight interest rate is the EONIA (Euro Overnight Index Average) for the euro area which is calculated as a weighted rate for the overnight maturity by collecting data on unsecured overnight lending in the euro area provided by banks belonging to the EONIA panel.

Inflation rate: Inflation is calculated as the year-on-year change in the Harmonised Index of Consumer Prices (HICP) for the euro area. The latter is the seasonally adjusted index based on consumption expenditure weights at irrevocable fixed exchange rates of 31 December 1998. Data before January 1995 are compiled from monthly rates of change of national CPIs excluding owner occupied housing (except for Spain). The seasonal adjustment methodology is described in the Technical Notes contained in the "Euro area Statistics" section of the ECB Monthly Bulletin.

Real GDP: the seasonally adjusted real GDP series (at market prices, constant prices taken 1995 as the base year), on a quarterly frequency, is constructed by following these steps: a) by aggregating national GDP data using the irrevocable fixed exchange rates of 31 December 1998 for the period 1980 Q1-1998 Q4; b) by re-scaling the series obtained so that it is consistent with the nominal GDP series in 1995[38]; c) by compiling an "artificial" series which, from 2000 Q4 onwards, covers the euro-12 series[39], whereas the observations from 2000 Q4 backwards are extrapolations based on growth rates calculated from the series compiled in points (a) and (b) above.

Unemployment: seasonally adjusted series of the standardised unemployment rate for the euro area (all ages), total (male and female), percentage of civilian workforce, provided by Eurostat.

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[38] The seasonally adjusted nominal GDP series – on a quarterly frequency – is constructed as follows: a) by aggregating national GDP data using the irrevocable fixed exchange rates of 31 December 1998 for the period 1980 Q1-1998 Q4; b) using, from 1999 Q1 onwards, the official Eurostat series (the series in point (a) is re-scaled to match the Eurostat series in 1999 Q1); c) by compiling an "artificial" series which, from 2000 Q4 onwards, covers the euro-12 series, whereas the observations from 2000 Q4 backwards are extrapolations based on growth rates calculated from the series compiled in points (a) and (b) above.

[39] For compiling the euro-12 series, the irrevocable fixed exchange rate for Greece determined on 19 June 2000 is used.

Commodity prices: they are represented by the world market prices of raw materials (total index) converted into euro. The weighting scheme is based on commodity imports of OECD countries, 1989-1991, excluding EU-internal trade.

Exchange rate: the nominal US dollar/euro (i.e. US $/euro) exchange rate is taken from the BIS and represents the exchange rate US dollar/1EUR(ECU), spot at 2.15 PM (CET), monthly average of daily data.

M3: it is constructed using the data on seasonally adjusted month-end stocks and flows. The series is constructed as follows. The seasonally adjusted index of adjusted stocks is re-based to be equal to 100 in January 2001 and then multiplied by the seasonally adjusted stock in January 2001. The percentage change between any two dates (after October 1997) corresponds to the change in the stock excluding the effect of reclassifications, other revaluations and exchange rate variations (and from January 2001 excluding the effect of the enlargement).

DJ Euro Stoxx: the Dow Jones (i.e. DJ) Euro Stoxx 325 Blue Chip Index is a capitalisation-weighted index of 325 European stocks from those countries participating in the EMU. The series is on euro basis (historical values of indices are calculated with historical daily exchange rates).

Oil prices: world-market prices, energy raw material, crude oil from the BIS database.

A.2 Real-time data

a) Latest available data

These data have been collected from the ECB Monthly Bulletins. The series have been constructed using the latest available data.

Inflation rate: the latest available data for inflation (Eurostat source) at each point in time.

Real GDP: the quarter-on-quarter changes have been used to re-calculated the quarterly real-time GDP series. Monthly series of the real GDP have been obtained by applying a cubic spline.

Industrial Production: the monthly growth rates calculated from the index (total industry excluding construction) published in the Bulletin has been applied to the January 1999 index for industrial production to re-calculate the corresponding real-time index.

b) SPF forecasts-based series

These data have been collected from the Survey of Professional Forecasters (SPF).

Inflation rate: inflation forecasts for next calendar year available at each point in time.

Real GDP: see point a) above.

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