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Institute for Monetary and Financial Stability
GOETHE UNIVERSITY FRANKFURT AM MAIN

WORKING PAPER SERIES NO. 102 (2016)

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Forward guidance and “lower for longer”: The case of the ECB

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February 10, 2016

Abstract

A number of contributions to research on monetary policy have suggested that policy should be asymmetric near the lower bound on nominal interest rates. As inflation and economic activity decline, policy should ease more aggressively than it would in the absence of the lower bound. As activity recovers and inflation picks up, the central bank should act to keep interest rates lower for longer than without the bound. In this note, we investigate to what extent the policy easing implemented by the ECB since summer 2013 mirrors the rate recommendations of a simple policy rule or deviates from it in a way that indicates a “lower for longer” approach to policy near zero interest rates.

JEL Codes: E43, E47, E52, E58
Keywords: Monetary policy, interest rates, European Central Bank, forward guidance, zero lower bound

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1. Introduction

A number of contributions to research on monetary policy have suggested that central banks should conduct policy in an asymmetric fashion near zero nominal interest rates. Savers can use cash as a means of storage that offers a zero nominal rate of return, in order to avoid negative deposit rates. Thus, after netting out the costs of storage and security associated with large cash holdings, the availability of cash creates a lower bound on the short-run nominal interest rate. As a result, there is a constraint on central banks' preferred policy instrument, the short-term rate on central bank reserves charged in bank-refinancing operations. Early contributions on policy near zero interest rates such as Reifschneider and Williams (2000) and Orphanides and Wieland (2000) found that an asymmetric approach would help reduce the impact of this constraint in macroeconomic models of a New Keynesian variety with nominal rigidities. As inflation and economic activity decline, policy should ease more aggressively than it would in the absence of the zero bound. As economic activity recovers and inflation picks up, the central bank should act to keep interest rates lower for longer than without the bound. These findings were referred to by policy makers (cf. Bernanke 2002) and confirmed in subsequent research using New Keynesian models with additional microeconomic foundations such as Adam and Billi (2006, 2007) and Nakov (2008). Most recently, the "lower for longer" argument has been used to justify delaying lift-off of the federal funds rate in the United States, for example by Evans et al (2015). The lower bound is also a key argument in favour of using "forward guidance" communication to provide support for market participants' anticipation of a sustained period of zero interest rates (cf. Eggertson and Woodford 2003).

In July 2013 the European Central Bank's (ECB) Governing Council provided specific forward guidance for euro area monetary policy by stating that it expects ECB interest rates to remain at present or lower levels for an extended period of time. ECB President Draghi explained that an estimate of this period could be deduced from a reaction function. In this note, we investigate to what extent the policy easing implemented by the ECB since summer 2013 mirrors a simple policy rule that incorporates reactions to inflation and real output. First, we consider the best-known simple policy rule, the so-called Taylor rule (Taylor 1993). This rule described the U.S. Federal Reserve's policy quite well between 1988 and 2002 (cf. Poole 2007). It also captured average policy rates of euro area member states surprisingly well during the run-up to monetary union from 1990 to 1999 (see Gerlach and Schnabel 2000). Prior to the global financial crisis, between 2002 and 2007, the federal funds rate stayed much below Taylor rule prescriptions (cf. Taylor 2007). And more recently the Fed delayed policy lift-off relative to this rule. Our application to euro area data indicates that the ECB also set rates below Taylor rule prescriptions in the years prior to the financial crisis, and again more recently.

Yet, it could be argued that the Taylor rule was never a good description of ECB policy and therefore cannot serve to identify deviations near the zero bound. Hence, in a second step, we compare ECB interest rate decisions to the simple rule from Orphanides and Wieland (2013). This rule matches quarterly changes in the ECB policy rate between 1999 and 2012 quite well. It models the first difference of the policy rate as a reaction to forecasts of inflation and output growth from the ECB's Survey of Professional Forecasters (SPF). The interest rate band derived from this rule contains more than two third of the changes in the ECB's main-refinancing rate between 1999 and 2013. We then proceed to estimate several specifications of this first-difference or change rule empirically with data up to summer 2013. We find that SPF forecasts dominate ECB staff forecasts as explanatory variables in terms of fitting ECB Governing Council decisions.

The change rule can be used to generate projections of future policy decisions on the basis of longer-range SPF forecasts. These projections can be related to the forward guidance provided by the ECB since summer 2013 (see also Bletzinger and Wieland 2013). In 2013 and 2014, these projections implied relative brief periods of constant interest rates lasting typically between 4 and 7 quarters. Finally, we explore to what extent recent ECB policy decisions, including unconventional measures, indicate a lower-for-longer approach to monetary policy at the zero-lower bound. As a result of the ECB's decision to initiate large-scale purchases of government debt in January 2015, short-, medium- and longer-term interest rates have fallen into negative territory. Interest rates at the short end are already more than half a percentage point below the simple reaction function that closely tracks the path of past interest rate changes.

2. ECB Style Forward Guidance

On July 4, 2013 the ECB Governing Council took the unprecedented step of stating its expectation for future interest rates more specifically:

> "*Looking ahead, our monetary policy stance will remain accommodative as long as necessary. The Governing Council expects the ECB interest rates to remain at present or lower levels for an extended period of time. This expectation is based on the overall subdued outlook for inflation extending into the medium term, given the broad-based weakness in the real economy and subdued monetary dynamics.*"

By providing information on expected future policy decisions, policy makers remove some of the uncertainty faced by market participants, namely uncertainty about the policy makers' anticipation of its own policy decisions. Of course, this anticipation is no fixed commitment. It depends on information that is currently available to them. Once new information becomes available, the policy maker may act differently and also anticipate different future decisions. With such announcements central banks try to guide market expectations. Some central banks even publish numerical forecasts of policy rates together with forecasts of inflation and economic activity.[1]

[1] See Norges Bank (2013) and Sveriges Riksbank (2013) for descriptions of their practice.

ECB President Mario Draghi has explained the ECB's approach as follows: "*our formulation of forward guidance is in line with our strategic framework, which is anchored in our assessment of the medium-term outlook for inflation, or price stability. And this outlook depends on economic activity and on money and credit developments. So this is our strategic framework, within which we can say that medium-term inflationary expectations remain firmly anchored."* (ECB Press conference, August 1, 2013)

Accordingly, the ECB forward guidance is being conditioned on its macroeconomic outlook. This conditioning on the outlook is done in a way that corresponds to the ECB's regular justification of the decision on current policy rates. It includes a review of the first pillar of the ECB's strategy, its so-called economic analysis comprising the inflation and growth outlook, and the second pillar, its so-called monetary analysis or cross-checking with monetary and credit developments. Consequently, the anticipated policy rate path will change whenever policy makers' expectations of future macroeconomic developments change. Thus, the ECB's forward guidance does not necessarily conflict with earlier statements that the Governing Council does not pre-commit itself.

The exact numerical expectation of the policy path and the length of time, for which the Governing Council anticipates policy rates to stay at current or lower levels, remain uncertain to market participants. However, in 2013, President Draghi stressed that "*there is no precise deadline for this extended period of time. As a matter of fact, you can … extract a reaction function and, from there, estimate what would be a reasonable extended period of time*". Hence, it is of great interest to compare the ECB decisions as well as its forward guidance to a simple reaction function or policy rule (see also Bletzinger and Wieland 2013).

3. ECB policy and the Taylor rule

Taylor (1993) found that a simple interest rate rule that performed well in simulations of a range of macroeconomic models studied in Bryant et al (1993) also closely fitted actual Federal Reserve decisions between 1988 and 1992. The Taylor rule relates the level of the federal funds rate to two dynamic factors, namely the deviation of current inflation measured by the GDP deflator from a constant target of 2 percent and the percentage deviation of current GDP from potential measured by a trend. The static factors entering the rule include an estimate of the equilibrium real interest rate of 2.0 percentage points and response coefficients of 0.5 on the inflation deviation from target and the output gap. The mathematical expression is given by:

$$i_t = 2.0 + \pi_t + 0.5 \cdot (\pi_t - 2.0) + 0.5 \cdot y_t \qquad (1)$$

Here i_t denotes the interest rate, π_t the inflation rate over the previous four quarters and y_t the output gap. This gap is defined as follows, $y_t = 100 \cdot \frac{Y_t - Y_t^*}{Y_t^*}$, where Y_t and Y_t^* are real output and real potential output, respectively. Poole (2007) showed that a version of the rule with real-time estimates of the output gap by the Federal Reserve staff also fitted Fed policy quite well between 1988 and 2002. From then on until the start of the global financial crisis in 2007 the federal funds rate stayed substantially below the Taylor rule prescriptions (see also Taylor 2007). More recently the Fed delayed policy lift-off relative to the Taylor rule. Evans et al (2015), for example, refer to the “lower for longer” approach at the zero bound in arguing for delaying lift-off.[2]

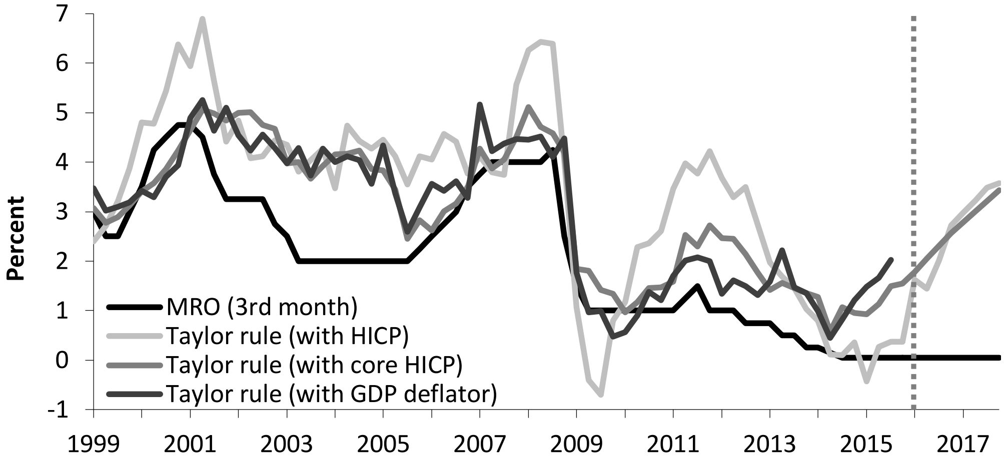
Gerlach and Schnabel (2000) showed that the Taylor rule also matched average policy rates of euro area member states during the run-up to monetary union from 1990 to 1999 surprisingly well. Thus, we proceed to apply the Taylor rule to the period of ECB policy for the union as a whole from 1999 onwards. **Figure 1** compares the ECB’s main

[2] The practical importance of interest rate rules is highlighted by a legislative proposal submitted in US Congress in June 2015 (Federal Reserve Accountability and Transparency Act 2015). This would oblige the Fed to communicate its own rule and explain deviations from it and the Taylor rule on a regular basis. In this way, it could reduce uncertainty regarding the exit from the low interest rate policy (Orphanides, 2015). Critics instead fear that it will result in too much political pressure on the Fed.

policy rate, that is, the interest rate on the main refinancing operations (MRO rate) to three different versions of the Taylor rule. All three versions use the same coefficients as the original Taylor rule and an identical measure of the euro area output gap derived on the basis of the European Commission's estimate of euro area potential output. They differ only in the measure of inflation. One version uses the overall harmonized index of consumer prices (HICP), another one the HICP excluding energy and certain food prices (core HICP), and the third one the GDP deflator. The data series for the three measures of inflation are shown in **Figure 2**.

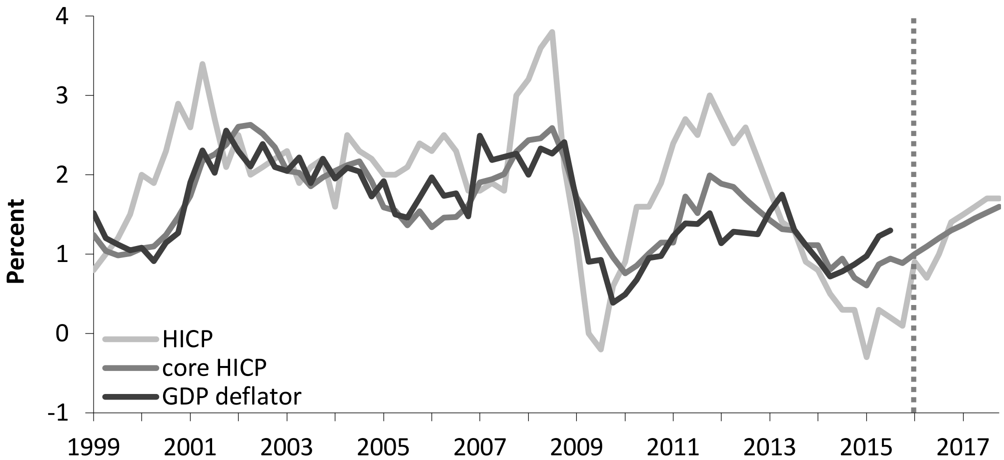
First, the Taylor rule prescriptions using the overall HICP measure are highly variable. They rise to levels between 6 and 7 percent in 2001-2002 and 2008, and to levels between 4 and 5 percent in 2011-2012. In 2009 they drop just below 0 percent and again at the start 2015. The comparison of inflation measures in **Figure 2** serves to show that the high variability results from short-run volatility in energy prices. The core index varies much less and the overall index always exhibits a reversion towards the core in the medium term. The core index reflects the inflation trend and provides a medium-term outlook for the overall index. Thus, not surprisingly, the ECB's current forecast for the overall HICP rises towards the current core index and eventually towards the average of the core and overall indexes observed in the past. This can be observed in the forecast period in figure 2. The Taylor rule calculation using the HICP underscores the need for monetary policy to focus on a core-index or a medium-term forecast for the overall index in order to avoid causing too extreme interest rate spikes. Indeed, when using the core HICP in the Taylor rule the resulting interest rate prescriptions follow a much smoother path similar to the version with the GDP deflator that was employed in the original Taylor rule for the United States. While the GDP deflator does incorporate effects of volatile energy prices, it also takes into account the behavioral response of households and firms to relative price changes. They effectively substitute relatively cheaper goods for relatively more expensive goods in production and consumption.

Figure 1: MRO rate versus real-time Taylor rule with different inflation measures



Notes: The graph shows the ECB's interest rate on its main refinancing operations in the *third* month of each quarter and the rates prescribed by the Taylor rule using the output gap and different measures of inflation. Inflation and output data up to 2015:Q4 is obtained from the ECB's real-time database. The vertical dotted line indicates the start of the forecast period. The forecasts are ECB staff projections (quarterly projections for HICP and output and interpolated annual projections for core HICP). Potential output data throughout the whole period is obtained in real-time from the macro-economic database (AMECO) of the European Commission.

Figure 2: Different measures of inflation in the euro area



Notes: The values from 1999:Q1 up to 2015:Q4 are from the ECB's real-time database, which can differ substantially from final vintage numbers. This is important as real-time data was already available in the respective periods. The vertical dotted line indicates the start of the forecast period. These forecasts are ECB staff projections. Whereas overall HICP projections are provided by the ECB in quarterly steps, core HICP is based on annual projections.

During the years 2002 to 2006, the Taylor rates with core HICP and the GDP deflator lie above the ECB's MRO rate. Just as in the case of the Fed, the Taylor rule would have recommended a tighter monetary policy prior to the financial crisis. Higher interest rates might well have helped slowing down the credit and house price booms in certain euro area member countries before the financial crisis. In 2009 the Taylor rule called for lowering the MRO rate to about 1 percent just as the ECB did. Since 2011 the rate prescriptions from the Taylor rule again exceeded the MRO rate. At the end of 2015 they lie a bit more than 1 percentage point above the MRO rate of 0.05 percent. The Taylor rule uses an inflation target of 2 percent. Yet, the ECB's inflation objective is defined as below but close to 2 percent. If one would use a value that is consistent with this definition, say 1.75 percent, the resulting Taylor rule prescriptions would increase by 12.5 basis points.

A recurring argument in current monetary policy discussions about the Taylor rule is that the equilibrium real interest rate has fallen and the recommended rate is therefore lower (Yellen, 2015). This would justify the present interest rate level. However, estimated long-term equilibrium interest rates are currently only slightly below 2 percent (see GCEE 2015). If a medium-term equilibrium concept is applied, the estimates are much lower, but the output gap would also have to be adjusted, as GDP would be accordingly closer to potential output. This would raise the Taylor rate again (Beyer and Wieland 2015).

Thus, from the perspective of the Taylor rule, the ECB is currently implementing a "lower for longer" approach at near zero interest rates. Yet this deviation is not unusual, because ECB policy has been different from Taylor's rule for much of the period since it has been in charge of euro area monetary policy. By contrast, a simple rule for the change of the interest rate fits past ECB policy quite well as shown in Orphanides and Wieland (2013).

4. A reaction function that fits ECB policy quite well

The interest rate rule considered by Orphanides and Wieland (2013) (OW) takes the following form:

$$i_t = i_{t-1} + 0.5 \cdot \left(\pi_{t+3|t} - \pi^*\right) + 0.5 \cdot (q_{t+2|t} - q^*_{t+2|t}) \qquad (2)$$

It is not a rule for the level of the policy rate such as the Taylor rule, but for the first difference. Hence it does not require an estimate of an equilibrium rate. Accordingly, the central bank changes the policy rate from the preceding level whenever the forecast for inflation deviates from the central bank's inflation objective or the GDP growth forecast deviates from the estimated growth potential. π denotes the rate of inflation, π^* the inflation target, q the growth rate of GDP and q^* the growth rate of potential GDP. The time index t is quarterly. Thus, the subscript t+3|t (t+2|t) denotes the forecast of a particular variable 3 quarters (2 quarters) into the future. The reaction coefficients are set at 0.5 such that a one-percentage-point deviation of the inflation forecast from target or the output growth forecast from potential would result in a 50 basis point adjustment of the policy rate.[3]

Despite its simplicity, this rule already incorporates two of the concerns mentioned by the ECB statement, namely the outlook for inflation and the outlook for economic activity. It does not include an explicit measure of monetary dynamics. However, it could be extended to include ECB-style monetary cross-checking as in Beck and Wieland (2007, 2008).

Ideally, one would want to feed ECB Governing Council members' forecasts of inflation and output growth into this reaction function. For example, Orphanides and Wieland (2008) have used publicly available forecasts of members of the Federal Open Market Committee to estimate a forecast-based rule for the United States.[4] Given that ECB President Draghi has explained that the ECB's statement about future policy rates

[3] Orphanides and Wieland (2013) show that a rule with these coefficients matches historical ECB rate decisions surprisingly well. They also investigate the optimal choice of such response coefficients as well as the forecast horizons by evaluation the stabilization performance of these rules in different macroeconomic models of the euro area.

[4] See also Wieland (2012) for an estimate of the likely date of lift-off of the federal funds rate in the US.

reflects the expectation of policy makers,[5] it would be appropriate to follow the same approach here.

Unfortunately, however, the inflation and output growth forecasts of ECB Governing Council members are not publicly available. Instead, Orphanides and Wieland (2013) use information from the Survey of Professional Forecasters (SPF) that is collected by the ECB and published in the second month of every quarter shortly after the policy meeting of that month. Specifically, they use the 4-quarters-ahead forecast from the most recent data point available. The respective forecast horizons – from the quarter of the policy decision and publication of the SPF survey – correspond to t+3 quarters for CPI inflation and t+2 quarters for GDP growth, due to the different timing and frequency of CPI inflation and GDP growth data releases. Hence, the different timing of the forecast deviations in the rule in equation (2) is determined by the availability of data on forecasts.

Taking into account the ECB's inflation objective of below but close to 2 percent, OW consider a target range of 1.5 to 2 percent. As a consequence, the rule implies a range of interest rate prescriptions of a width of 25 basis points. As to potential growth OW employ the estimate produced by the European Commission, because the ECB's estimate is not made public. [6]

Figure 3 compares the historical interest rate prescriptions from the OW rule with the ECB's MRO rate. The range of prescriptions matches the ECB's policy decisions very well. It does so even though the rule does not include additional information on monetary dynamics. This result is consistent with the finding that cross-checking the ECB's first pillar with longer-term trends in monetary and credit dynamics only requires

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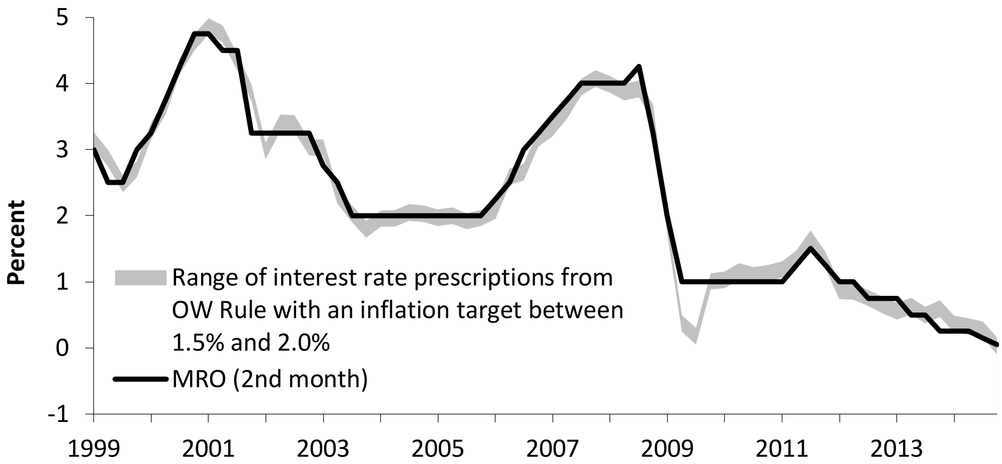
[5] The complete quote of Draghi is *"… it is more than a forecast. Allow me to point out that the statement says 'We expect'. It does not say 'It is expected' and it does not say 'An international institution expects'; it says 'We – the policy-makers – expect the key ECB interest rates to remain at the present or lower levels for an extended period of time'. So, it is an expectation by a very specific set of policy-makers."*

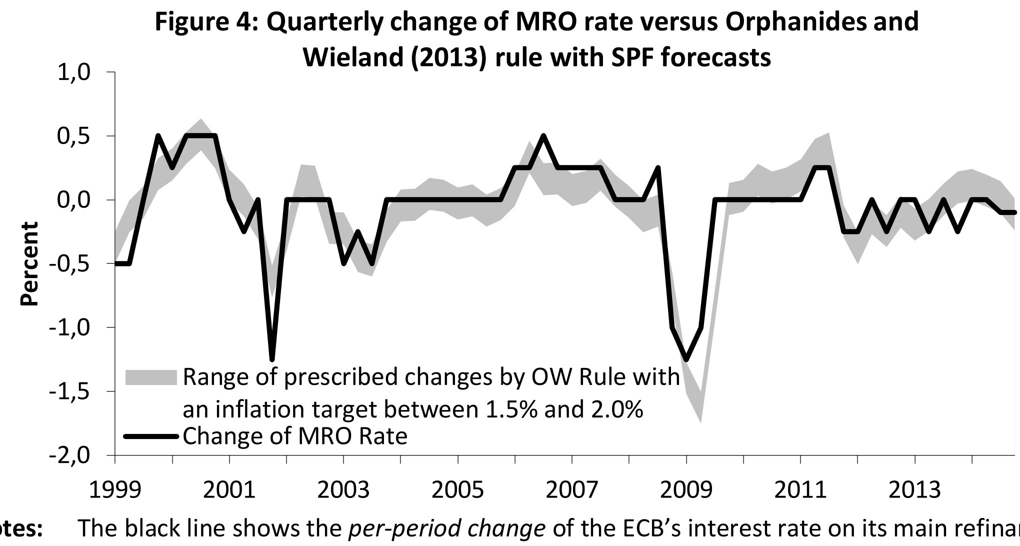
[6] To obtain quarterly estimates OW interpolate the annual estimates from the annual macro-economic database (AMECO) of the European Commission.

occasional adjustments in the policy stance, while short-run information on money and credit may also be accounted for in the outlook for GDP (Beck and Wieland 2008). The good fit does not just result from including the lagged interest rate in the rule. **Figure 4** compares the actual quarterly changes of the MRO rate to the changes prescribed by the rule.

Figure 3: MRO rate versus Orphanides and Wieland (2013) rule with SPF forecasts



Notes: The black line shows the ECB's interest rate on its main refinancing operations in the *second* month of each quarter from 1999:Q1 to 2014:Q4. The grey shaded area is constructed with the OW rule: MRO rate = (previous MRO rate) + 0.5(3-quarter ahead forecasted inflation deviation from target) + 0.5(2-quarter ahead forecasted GDP growth rate gap from potential). The lower line of the shaded area has an inflation target of 2 percent and the upper line a target of 1.5 percent. The forecast data is from the ECB Survey of Professional Forecasters (SPF) and EC AMECO.

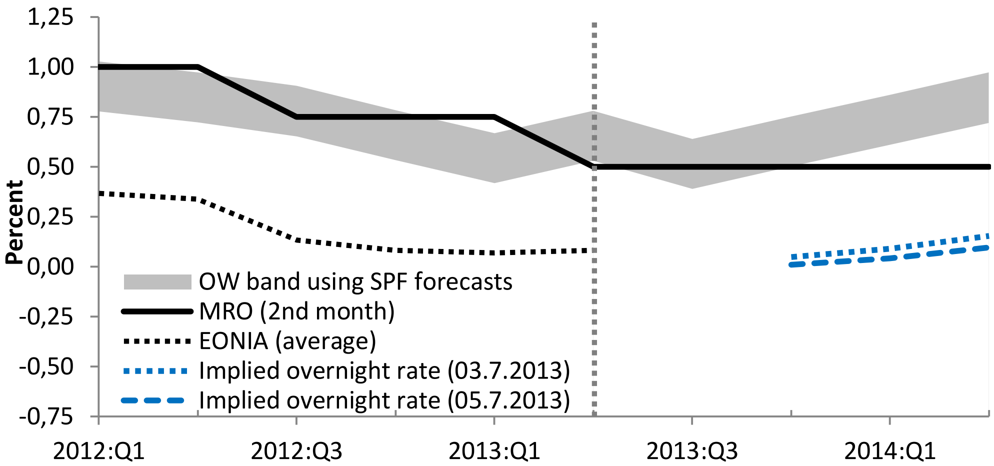


Notes: The black line shows the *per-period change* of the ECB's interest rate on its main refinancing operations in the *second* month of each quarter from 1999:Q1 to 2014:Q4. The grey shaded area is constructed with the OW rule: MRO rate - previous MRO rate = 0.5(3-quarter ahead forecasted inflation deviation from target) + 0.5(2-quarter ahead forecasted GDP growth rate gap from potential). The lower line of the shaded area has an inflation target of 2 percent and the upper line a target of 1.5 percent. The forecast data is from the ECB Survey of Professional Forecasters (SPF) and EC AMECO.

Overall, the changes in the MRO rate are captured quite well by the OW rule, with respect to the direction, magnitude and timing of the changes. On most occasions prior to the start of the ECB's forward guidance in the third quarter of 2013, the band includes the actual change in the MRO rate. When rounding the band to 5 basis points in the second decimal place, in line with normal settings of MRO rates, 78 percent of rate changes fall within the estimated range. Rounding the band to 25 basis points, which represents the smallest observed rate change prior to 2014, puts 83 percent of policy changes within the band.

The explanatory power of the OW rule is rooted in the deviations of the SPF forecasts from the respective reference values. These forecasts are collected for the ECB Governing Council meetings every quarter and published after the respective meeting. The change rule thus establishes a connection between the current state of information at the time of the meeting and the monetary policy decision taken during the meeting. The prevailing MRO rate set a quarter ago has no explanatory power for the rate change from this level.

Figure 5: Orphanides and Wieland (2013) rule with SPF data until 2013:Q2



Notes: The graph shows the ECB's interest rate on its main refinancing operations, the EONIA rate and the band prescribed by the OW rule from 2012:Q1 up to 2013:Q2. Thereafter, forecasts are shown for four quarters ahead. The EONIA forecast, given by the implied overnight rate provided by the ECB, is shown one day before and one day after the ECB Governing Council's forward guidance announcement.

Figure 5 reports the results of a projection of the OW rule at the time of the forward guidance announcement in 2013:Q2 for the subsequent for quarters. This projection is computed by simulating the OW rate forward using the 8-quarters-ahead forecasts that are available from the SPF. [7]

The next rate hike from the prevailing level of 0.5 percent is projected to occur in the first or second quarter of 2014. Relative to the ECB's announcement that it expects rates to stay at current or lower levels for an extended period of time, this period appears relatively brief. By contrast, the implied future overnight rates from early July 2013 remain below 0.25 percent and are only slightly tilted upwards over this period. These implied rates are available from the ECB and calculated by applying the Svensson (1994) model to daily euro area government debt yields. The two series shown are from the days before and after the date of the ECB's announcement on July 4, 2013. The lower level of these market rates does not result directly from the ECB's announcement. Rather, market rates have been below the MRO rate since the ECB has introduced full allotment in its open market operations in 2008. Since then the EONIA rate fluctuates close to the ECB's deposit rate which serves as a lower bound for overnight money market rates. Indeed, the implied future rates from the yield curve in **Figure 5** remain close to the prevailing EONIA rate in the second quarter of 2013.

5. Regression results

Orphanides and Wieland (2013) do not report estimation results that would indicate what type of rule and what coefficient values provide the best empirical fit to the ECB's policy decisions. Besides determining point estimates and confidence intervals for the response coefficients, such an estimation would provide information on the inflation target that is consistent with ECB policy decisions. Assuming that the target is constant

[7] The first-difference rule can be simulated forward in dynamic or static fashion. The dynamic projection would replace the lagged MRO rate from quarter t-1 with the value fitted for quarter t, when calculating the value projected for quarter t+1 and repeat this replacement process for projections for subsequent quarters. The static simulation instead repeats the calculation without dynamically replacing the current value. We use the static simulation that provides an indication of the next rate change only.

over time and that the level of the interest rate does not feature a deterministic trend, the estimation equation can be written as:

$$\Delta i_t = \beta_0 + \beta_1 \pi_{t+3|t} + \beta_2 (q_{t+2|t} - q^*_{t+2|t}) + \varepsilon_t \tag{3}$$

The implied inflation target is defined by the negative ratio of the intercept and the response coefficient on inflation, $\pi^* = -\beta_0/\beta_1$. Column 1 in **Table 1** reports an ordinary least squares (OLS) regression of equation (3) using the data on SPF forecasts that was employed in the previous section with the OW rule. The estimated coefficient on the inflation forecast of 0.49 is effectively the same as the 0.5 value used by OW. The coefficient on the output gap is a bit lower at 0.40. Yet, the OW value of 0.5 lies just at the upper border of the estimated 95% confidence interval. The point estimate of the inflation target of 1.72 percent lies just about in the middle of the 1.5 percent to 2 percent range used by OW and in Figures 3 to 5. It is fully consistent with the official definition of the inflation objective by the ECB as close but below 2 percent. The 95 percent confidence interval ranges from 1.60 to 1.84. Thus, our estimated interest rate reaction function supports the view that the ECB has been setting interest rates in line with its stated inflation objective over this period.

With an R-squared of 0.69 the fitted equation explains about 2/3 of the changes in the MRO rate. By comparison, a regression of the first difference of the MRO rate on the lagged first difference results in an R-squared of only 0.23. Thus, the outlook for inflation and growth embodied in the SPF forecasts and the EU Commissions estimate of potential growth has a substantial additional explanatory power over past interest rate changes. Furthermore, the regular OLS regression allows for a continuous interest rate adjustment. If the estimation were to take into account that interest rate changes typically occurred in steps of 25 or 50 basis points, it would explain an even greater part of the policy decisions.

Table 1: Estimated interest rate rules

Dep. Variable: first difference of MRO rate	(1) OLS with **SPF data** only	(2) OLS with **staff data** only	(3) NLS one unrestricte d weight	(4) NLS one restricted weight	(5) NLS two unrestricte d weights	(6) NLS two restricted weights
$\alpha_1 = \alpha_2$			1.20 [1.05; 1.34]	1.00 [0.96; 1.00]		
β_1	0.49 [0.25; 0.72]	0.07 [-0.15; 0.29]	0.70 [0.38; 1.02]	0.46 [0.09; 0.83]	0.78 [0.43; 1.13]	0.46 [0.09; 0.83]
α_1					1.06 [0.80; 1.31]	1.00 [0.32; 1.00]
β_2	0.40 [0.32; 0.49]	0.17 [0.07; 0.27]	0.40 [0.31; 0.49]	0.37 [0.28; 0.47]	0.39 [0.29; 0.48]	0.37 [0.22; 0.53]
α_2					1.35 [1.06; 1.64]	1.00 [0.85; 1.00]
$\pi^* = -\beta_0/\beta_1$	1.72 [1.60; 1.84]	1.79 [0.14; 3.44]	1.74 [1.65; 1.82]	1.74 [1.60;1.88]	1.79 [1.68; 1.90]	1.74 [1.57; 1.91]
R-squared	0.69	0.35	0.70	0.67	0.71	0.67
Adj. R-squared	0.68	0.33	0.69	0.65	0.69	0.64
Durbin-Watson stat.	2.05	1.61	2.37	2.17	2.40	2.17
Observations	58	50	50	50	50	50

Note: Whereas SPF data is available since 1991:Q1, the staff projections are only available since 2001:Q1. Thus, all columns except (1) make use of the shorter sample. All regressions use data until 2013:Q2. The 95 percent confidence intervals are given below the point estimates. The confidence intervals of the restricted weights are calculated by moving block bootstrapping with a block length of five quarters and 10,000 repetitions. In order to fully account for real-time considerations, we use the MRO difference in each quarter in which all data was available. Hence, column (1) uses the second month of the quarter and all others use the third month. If the second month rate is used instead, the estimation results do not change significantly.

SPF versus ECB staff forecasts

A natural question to ask is whether the ECB Governing Council's view regarding the outlook for inflation and growth would not be better approximated with the publically available forecasts of the ECB staff than the average of private sector SPF forecasts. ECB staff forecasts are only available in form of annual forecasts but not in form of constant-horizon forecasts from the most recent observation as in the case of the SPF. Thus, we approximate the constant-horizon forecasts called for in regression equation (2) by appropriately averaging annual staff forecasts (see Appendix 1). Of course, this process is likely to eliminate some of the variation in constant-horizon forecasts that is needed to explain the interest rate decision. Since the staff forecasts are made available for the ECB Governing Council meeting in the third month of the quarter we use the value of the MRO rate at that time in the regression. The second column in **Table 1** reports the estimates of equation (2) with ECB staff forecasts. The regression fit deteriorates substantially relative to the version with SPF forecasts. Also, the coefficient on the inflation forecast is not significantly different from zero.

The relative importance of SPF forecasts versus ECB staff projections in the empirical reaction function can also be examined by means of a nested regression of the form:

$$\Delta i_t = \beta_0 + \beta_1\left[\alpha_1 \pi_{t+3|t}^{SPF} + (1-\alpha_1)\pi_{t+3|t}^{staff}\right] + \beta_2\left[\alpha_2\left(q_{t+2|t}^{SPF} - q_{t+2|t}^{*}\right) + (1-\alpha_2)\left(q_{t+2|t}^{staff} - q_{t+2|t}^{*}\right)\right] + \varepsilon_t \qquad (4)$$

Orphanides and Wieland (2008) and Wieland and Wolters (2013) use the same nested regression technique in order to estimate weights for outcomes and forecasts of inflation and unemployment in empirical reaction functions for the U.S. Federal Reserve. Whereas we fix the forecast horizons according to the availability of the SPF data, we allow for different weights on SPF and ECB staff forecasts. To this end we estimate non-linear least squares (NLS) regressions. Column 3 reports estimates for the case where the weight on the two types of forecasts is the same for inflation and output growth ($\alpha_1 = \alpha_2$), whereas column 5 reports estimates when the weights can differ. These NLS regressions do not restrict the weights to take values between 0 and 1, which is why they are referred to as unrestricted. It turns out that the estimated weights on the SPF forecast are greater than unity.

Thus, in the next step, we restrict the weights to be non-negative and to add up to one.[8] Running such a regression requires searching for local optima within the limited interval for the weights with the possibility of an interior solution. The resulting

[8] To this end, the weights α_i and $1-\alpha_i$ are replaced in the regression with $e^{\theta_i}/(e^{\theta_i}+1)$ and $1/(e^{\theta_i}+1)$, respectively. **Table 1** still reports the transformed variables $\alpha_i = e^{\theta_i}/(e^{\theta_i}+1)$.

estimates are reported in columns 4 and 6. They indicate clearly that ECB interest rate decisions are better explained with SPF forecasts than with ECB staff forecasts. In both cases, the estimated weights are equal to unity. The regressions with both types of forecasts use the MRO rate from the third month in the quarter as dependent variable, because the ECB staff forecast only becomes available for the third-month meeting. At that time, the SPF forecasts are already a bit stale, which explains that the response coefficients are not always identical to the regression in column 1. Incidentally, the implied inflation target seems to be very robust across all regressions.

One might be tempted to conclude from these regressions that the ECB Governing Council puts more weight on private sector SPF forecasts in making its policy decisions than on the projections prepared by his own staff. Yet, this would be an over-interpretation. The ECB staff prepares quarterly projections for up to three years for the ECB Governing Council, but only the annual forecasts have been made public throughout the full sample period. That is why we interpolate annual staff projections to obtain an approximation of constant-horizon projections. It could well be that the exact constant-horizon projections of the ECB staff would provide a better empirical fit in the regressions than the constant-horizon SPF forecast. Unfortunately, however, the quarterly forecasts have only been made publicly available since March 2014. Otherwise, it would be an interesting exercise to repeat the estimation with constant-horizon forecasts computed from quarterly projections ranging further back in time.[9]

Estimated reaction function and ECB forward guidance

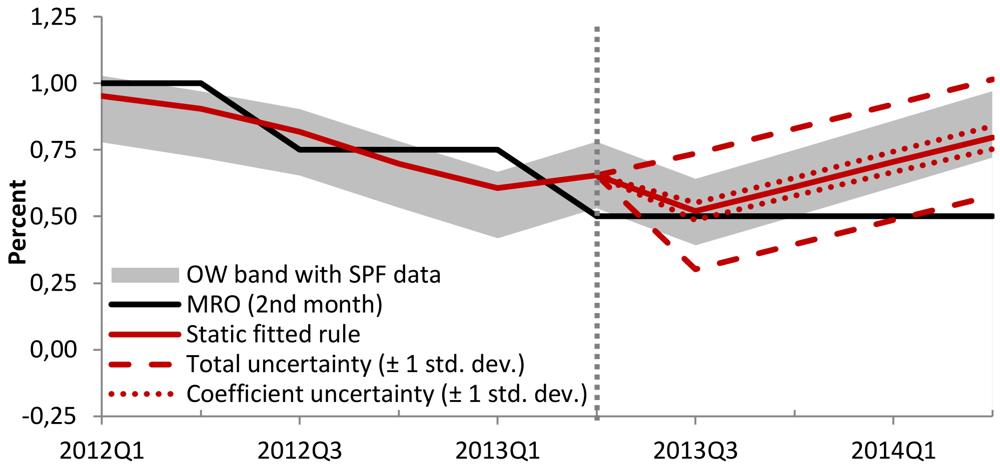
We proceed to use the regression estimates from column 1 to compute a reaction-function-based projection of future MRO rates at the time of the ECB's forward guidance announcement in July 2013. The results are shown in **Figure 6**. This exercise

[9] Another drawback of the public staff projections is that they do not fully reflect ECB staff projections. The figures are provided, on a rotating basis, by staff of the ECB only (March and September publications) and staff of the national central banks and the ECB (June and December publications). Thus, the methodology of the projections changes within the same time series. This makes it even harder to judge what the actual expectations of the ECB Governing Council members are.

mirrors the calculation with the OW rule shown previously in **Figure 5**. The latest fitted value (2013 Q2) lies almost exactly in the middle of the band spanned by the OW rule prescriptions. Thereafter, the estimated reaction function suggests that the MRO rate would remain at the current or lower level till at most the second quarter of 2014. Again, this projection is obtained using the 8-quarter-ahead SPF forecasts. The finding is similar to the calculation with the OW rule.

Figure 6 also displays confidence intervals for the estimated forecast. The larger interval (indicated by the dashed red lines) reflects total uncertainty of the estimate consisting of residual and coefficient uncertainty. The residual uncertainty reflects uncertainty about the specification of the estimation equation and about how well the ECB Governing Council's expectations are approximated with SPF forecasts. Removing this residual uncertainty from the confidence interval provides another interval which only includes uncertainty about the coefficients in the reaction function (indicated by the dotted red lines) including the estimated inflation target. As shown in the figure, the band spanned by the OW rule with the 1.5 and 2.0 percent inflation targets always includes the interval with coefficient uncertainty.

Figure 6: Forecasting in 2013Q2 with estimated and OW rule

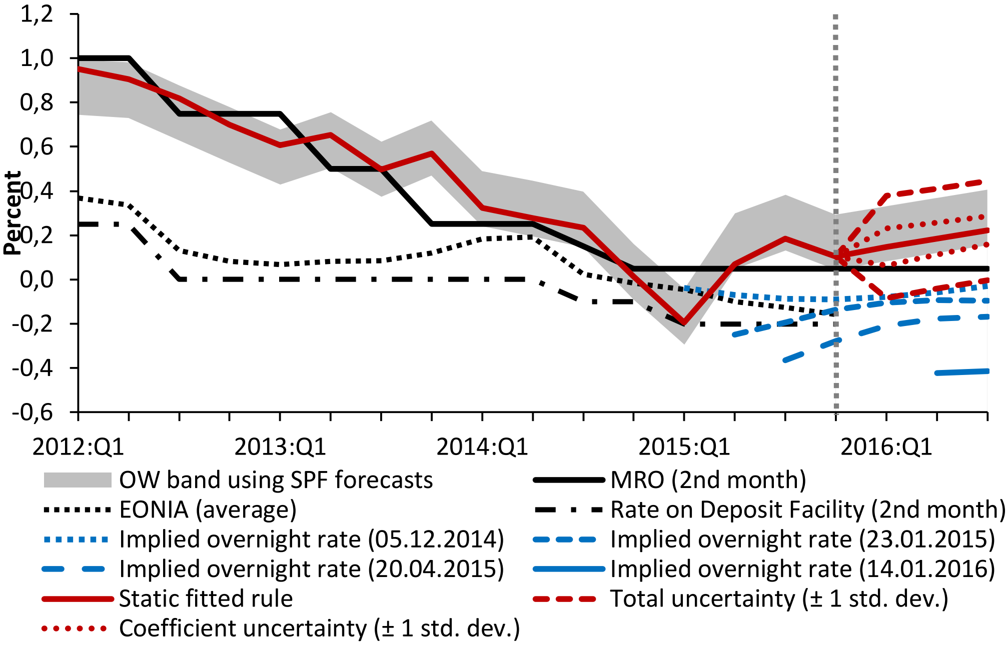


Notes: The black line shows the ECB's interest rate on its main refinancing operations in the *second* month of each quarter. The grey shaded area shows the OW band with SPF data. The red line shows the fitted and forecasted values from the regression given in column 1 of table 1. The red dashed and dotted lines show the forecasted values plus/minus one standard deviation using total and only coefficient uncertainly, respectively.

6. ECB Policy with near zero interest rates

Finally, we return to the question whether recent policy decisions of the ECB reflect a "lower for longer" approach to monetary policy near zero interest rates. **Figure 7** shows that the interest rate band resulting from the OW rule has moved above the MRO rate of 5 basis points in the last three quarters. The projection based on the 8-quarter head SPF forecasts calls for an increase in the policy rate in the course of 2016. Although the inflation forecast is below target, the forecast for GDP growth is sufficiently above the current estimate of potential growth to induce an increase in the rate prescription.

Figure 7: Estimated and OW (2013) rule versus different measures of monetary policy



Notes: The black and grey lines show the ECB's interest rates on its main refinancing operations and its deposit facility, respectively, in the *second* month of each quarter. The grey shaded area shows the OW band with SPF data. The blues lines show the EONIA rate and implied overnight rates from the ECB calculated at different points in time. The red line shows the fitted and forecasted values from the regression given in column 1 of table 1 using 2015Q4 as the starting point for the forecast. The red dashed and dotted lines show the forecasted values plus/minus one standard deviation using total and only coefficient uncertainly, respectively.

By contrast the ECB has implemented substantial additional monetary easing since the start of 2015. In particular, it has launched a large-scale government debt purchase programme. In January 2015 it announced government and private debt purchases on the scale of 60 billion Euro per month to last at least until September 2016. In December 2015 it extended the announced period of debt purchases further until at least March 2017 and decided to reinvest maturing debt for as long as necessary. The ECB's debt purchases imply a rapid increase in its balance sheet. Such a quantitative easing has effects on market interest rates, exchange rates and asset prices. They work through expectations by financial market participants, households and firms. But they also have direct quantitative effects on consumption, savings and investments decisions by households and firms. Indeed, early research on monetary policy near zero interest rates suggested resorting to balance sheet expansion when further policy easing is needed and recent contributions provide estimates of the effect of such measures (see Orphanides and Wieland 2000, Auerbach and Obstfeld 2005, Boeckx at al 2014, Gambacorta et al 2014, Georgiadis and Gräb 2015) .

Monetary policy transmission of central bank asset purchases occurs especially through signalling and portfolio rebalancing channels. The signalling effect works through the anticipation of lower policy rates in the future. After all, the announcement of debt purchases till March 2017 effectively postponed the possibility of a rate hike until after that date. The portfolio rebalancing channel works as follows. The debt purchases increase money supply. Sellers of bonds that do not regard the money received as a perfect substitute then tend to rebalance their portfolios by purchasing other assets that are better substitutes. As a result, prices for other assets increase, while risk premia decrease and result in lower medium- und longer-term interest rates.

The impact of the quantitative easing is visible in the implied future overnight rates from the yield curve. These implied rates have moved down substantially throughout the last year. By now they stand more than 50 basis points below the OW band and our estimated interest rate reaction function for 2016. Thus, the ECB policy easing implemented throughout 2015 has moved implied rates well below interest rate reaction functions that describe the historical interest rate decision making by the ECB quite well. Furthermore, the implied overnight rates are more than 20 basis points below the current EONIA rate and the ECB's central bank deposit rate.

8. Conclusion

The forward guidance provided by the ECB Governing Council since summer 2013 includes the expression that *"the Governing Council expects the ECB interest rates to remain at present or lower levels for an extended period of time."* As suggested by ECB President Draghi, we use reaction functions to evaluate whether the ECB as embarked on a "lower for longer" approach to monetary policy near zero interest rates.

ECB interest rate policy has been below the interest rate prescriptions from the original Taylor rule applied to the euro area for some time, both, before the start of the global financial crisis and again in more recent years. Furthermore, over the course of the last year, ECB policy has moved below a reaction function that fits historical ECB decisions quite well. To establish this finding, we first use the forecast-based first-difference rule from Orphanides and Wieland (2013) that employs private sector SPF forecasts of inflation and output growth that were available to the ECB Governing Council in real time. Then we proceed to estimate the coefficients of this rule. Our estimated response coefficients are very close to the coefficients assumed by OW. Furthermore, the estimated inflation target turns out to be consistent with the ECB's definition of the objective of close to but below 2 percent. We also investigate whether available annual ECB staff forecasts would help improve the reaction function's fit relative to the constant-horizon SPF forecasts employed so far. This is not the case, perhaps because it is key to use constant-horizon forecasts.

Especially, the extensive asset purchases since the start of 2015 have contributed to a decline in market interest rates. This becomes visible in form of anticipated future overnight rates derived from the yield curve that have moved substantially further below the interest rates implied by the reaction function in the course of 2015.

Contributions to the literature on monetary policy at near zero interest rates suggest that a “lower for longer” approach is effective in reducing deflation risk (see Orphanides and Wieland 2000, Eggertson and Woodford 2003, Evans et al 2015). Yet there are also other issues to be considered. At this occasion, inflation rates are driven near zero because of volatile oil prices but not prices on products that could be sticky. Furthermore, a long period of low interest rates is likely to increase the risk of financial instability and asset-price driven boom-bust cycles and to create incentives for euro area member states’ governments to postpone consolidation and reform efforts that are much needed to raise potential growth (see BIS 2015 and GCEE 2015).

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Appendix

This appendix explains how the raw data collected from the SPF, ECB staff and EC AMECO is transformed for our estimation. It should be kept in mind that the rule we use is a forecast-based rule. Hence, the inflation rate used to determine the interest rate in quarter t is the predicted inflation rate for t+3, based on information in quarter t. Similarly, the growth rates of GDP and potential GDP are the predicted values for t+2, based on information in quarter t. All our calculations and estimations employ real time data that was available to policy makers at the time of the policy decision. The calculation of the projected future forecasts based on the latest information available is illustrated for the growth rate of potential GDP in **Table A1**. The date at which the forecast is computed is 2013:Q2 as in **Figure 5**. The forecast at another date as in **Figure 7** can be computed in the same manner from the raw data.

Table A1: Raw data and calculation of potential GDP growth rates

Potential Growth by AMECO from 2013:Q2	**Raw data:**	**2013**	**2014**
		0.44	0.56
	Calculation		Potential Growth(+2)
2013:Q3	=0.75(2013) + 0.25(2014)		0.47
2013:Q4	=0.50(2013) + 0.50(2014)		0.50
2014:Q1	=0.25(2013) + 0.75(2014)		0.53
2014:Q2	=0.00(2013) + 1.00(2014)		0.56

Note: The raw data are real-time EC AMECO numbers available early May 2013.

Furthermore, the SPF contains two inflation forecasts from the most recent data release, which correspond to the third and the seventh quarter ahead from the current quarter. The published GDP growth rates are a two-quarter and a four-quarter-ahead forecast. Since the final SPF data point is given by 2013:Q2, future inflation and growth forecasts are calculated in the same fashion as in table A1. The forecasts and resulting OW rule prescriptions are shown in **table 2**.

Table A2: Raw data and calculation of the forecast-based OW rule with SPF forecasts

	Raw SPF Data from 2013:Q2	Inflation Rate		GDP Growth Rate		
		2014:Q1	1.60	**2013:Q4**	0.40	
		2015:Q1	1.80	**2014:Q4**	1.20	
Quarter	MRO Rate(-1)	Inflation(+3)	Growth(+2)	Potential Growth(+2)	OW Rule (Target 2.0)	OW Rule (Target 1.5)
2013:Q2	0.75	1.60	0.40	0.44	0.53	0.78
2013:Q3	0.50	1.65	0.60	0.47	0.39	0.64
2013:Q4	0.50	1.70	0.80	0.50	0.50	0.75
2014:Q1	0.50	1.75	1.00	0.53	0.61	0.86
2014:Q2	0.50	1.80	1.20	0.56	0.72	0.97

Note: The four raw data figures are taken from the ECB SPF 2013:Q2 publication. The OW rules are calculated as: MRO rate(-1) + 0.5[Inflation(+3) - Target] + 0.5[Growth(+2) - Potential Growth(+2)].

Finally, ECB staff projections are treated in the following way. They are not only published one month later in each quarter (hence, the benchmark MRO rate and the relevant real-time numbers of potential output might differ) but the growth rates always refer to years instead of quarters. Hence, the annual numbers are interpolated as in table A1. **Table 3** contains all the resulting information.

Table A3: Raw data and calculation of the forecast-based OW rule with ECB staff forecasts

	Raw Staff Data from 2013:Q2	Inflation Rate		GDP Growth Rate		
		2013	1.40	**2013**	-0.60	
		2014	1.30	**2014**	1.10	
Quarter	MRO Rate(-1)	Inflation(+3)	Growth(+2)	Potential Growth(+2)	OW Rule (Target 2.0)	OW Rule (Target 1.5)
2013:Q2	0.75	1.38	-0.60	0.35	-0.04	0.21
2013:Q3	0.50	1.35	-0.18	0.38	-0.10	0.15
2013:Q4	0.50	1.33	0.25	0.41	0.08	0.33
2014:Q1	0.50	1.30	0.68	0.45	0.26	0.51

Note: The four raw data figures are taken from the ECB staff June 2013 publication. The OW rules are calculated as: MRO rate(-1) + 0.5[Inflation(+3) - Target] + 0.5[Growth(+2) - Potential Growth(+2)]. The potential growth rates are calculated as in table 1 but differ due to real-time calculations.

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