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Announcements of Interest Rate Forecasts: Do Policymakers Stick to Them?*

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Abstract

If central banks value the ex-post accuracy of their published forecasts, previously announced interest rate paths might influence the current policy rate. We explore if "forecast adherence" has affected monetary policy in New Zealand and Norway, where central banks have published their interest rate forecasts the longest. We derive and estimate policy rules with separate weights on past interest rate forecasts, and find that they have explanatory power for current policy decisions, over and above their correlation with other conventional interest rate rule arguments.

Keywords: Interest rates, forecasts, Taylor rule, adherence

JEL Classifications: E43, E52, E58

1 Introduction

According to some economic theory, monetary policy predominantly affects the economy through expectations regarding the future path of short-term interest rates.[1] This insight takes center stage in the debate on "forward guidance" and has motivated a number of central banks to communicate their policy intentions explicitly by publishing their own forecasts of future interest rates.[2] However, the practice of announcing policy intentions has long been controversial, and on both sides of the debate a key argument is that past announcements might constrain future policy decisions. On the one hand, forward guidance is more effective if the central bank eventually implements signaled policy than if the guidance simply provides the central bank's view on likely future economic developments (Woodford (2012)). Adhering to past announcements would be beneficial in this respect (Gersbach and Hahn (2011)). On the other hand, such adherence could prevent sufficiently strong policy response to shocks.[3] Even though there is a rich theoretical debate on the desirability of announcing interest rate forecasts, empirical evidence on the link between past announcements and future policy is scarce. Our paper attempts to close this gap.

We derive a simple policy rule for a central bank that perceives deviations from its previously announced forecasts as costly, and therefore has an incentive to stick to them. The specification is sufficiently flexible to nest a broad class of interest rate rules proposed elsewhere in the literature. We may therefore use several alternative policy formulations as we aim to separate the effect of previously published interest rate forecasts from the effects of other macroeconomic variables. The rules are estimated on the actual policy rates of the Reserve Bank of New Zealand (RBNZ) and Norges Bank, the Central Bank of Norway, in order to address the question: do announced interest rate forecasts influence actual policy decisions?

Our findings are consistent with the hypothesis that both the RBNZ and Norges Bank have placed weight on their previously announced interest rate forecasts when setting policy rates. For the policy decision in a given quarter, the central banks' most recent interest rate forecasts have explanatory power separate from that of the other macroeconomic variables we consider. Older forecasts have no effect on the current policy rate, once the most recent forecast is controlled for. These results hold when we formulate policy in line with alternative approaches, such as the reaction functions suggested by the institutions themselves, by Clarida, Galí, and Gertler (2000), or by Levine, McAdam, and Pearlman (2007). The estimated effects of past interest rate paths are significant also after controlling for past and future policy rates, as well as for residual autocorrelation as recommended by Rudebusch (2002).

An important question concerns how to interpret our estimated weights on past forecasts; do they reflect adherence to previous paths or correlation with omitted variables? To deal with this issue, we add several financial market controls sequentially, and find that the past central bank forecasts remain important. In addition, we address the possibility that central banks might be averse to surprise markets, as discussed by Svensson (2003) and Rudebusch (2006). Within the samples where central banks publish their forecasts, one cannot expect to precisely distinguish surprise aversion from adherence, as short term market forward rates are highly correlated with central bank forecasts and the two possible mechanisms would complement each other. However, because Norway's monetary policy regime was stable around its introduction of forecast publication in 2005, we can study the weight on market forward rates before and after interest rate forecasts were published.[4] We do this by replacing Norges Bank forecasts with market forecasts, as implied by forward rates, and estimate policy rules separately for the periods before and after 2005. We find a positive coefficient on market forecasts in both sub-periods, but the point estimate is higher *after* 2005. Moreover, if we control for Norges Bank's own forecasts, the weight on market forecasts drops out, while the coefficient on Norges Bank forecasts remains significant.

Our paper relates to several studies of market reactions to monetary policy announcements, that typically use data of higher frequency than we do. Andersson and Hofmann (2009) and Moessner and Nelson (2008) both find moderate, but statistically significant, responses of market rates to interest rate path announcements. More recently, Campbell, Evans, Fisher, and Justiniano (2012) measure forward guidance by the Federal Reserve and estimate its macroeconomic impact. They distinguish between "Delphic" and "Odyssean" forward guidance. Delphic guidance informs agents about the central bank's forecast of macroeconomic performance and likely policy response to it, without implying commitment to any course of action. Odyssean guidance, in contrast, has a commitment effect. While we cannot exclude that our adherence estimates capture Delphic guidance, by proxying for omitted variables, our exercise with market forecasts supports the interpretation that the estimates reflect Odyssean effects too.

Kool and Thornton (2012) explore time-variation in market participants' interest rate forecasts. They find that the accuracy of these forecasts improved after interest rate paths were introduced in Norway, but that this did not happen in New Zealand. Based on our findings, one might have expected improved forecast performance in both countries. One possible reason why forecasts were not improved in New Zealand might be that central bank communication induced market participants to under-utilize other useful, private sources of information, as in the theory of Morris and Shin (2002). Interestingly, Kool and Thornton (2012) find some support for this mechanism when studying market participants' forecast dispersion. Hence, even if past interest rate paths carry some weight in policy decisions, the practice of announcing interest rate paths might still *increase* forecast errors, if it reduces market participants' attention to other variables that affect interest rate decisions.

This paper is organized as follows. In Section 2, we explain the institutional setting that we study. Section 3 explains our empirical strategy and the data we use. Section 4 reports our main results. Section 5 concludes.

2 Institutional Setting

This section reviews the institutional details most relevant to our study. Table 1 in the appendix reports the publication dates of all the interest rate forecasts in our sample.

2.1 Reserve Bank of New Zealand

Starting in March 1997, the Reserve Bank of New Zealand (RBNZ) was the first central bank to publish its own interest rate forecasts. The interest rate being forecast is the quarterly average of the 90-day Bank Bill rate, and it is projected for each of the next 8 quarters. This interest rate path is published in the quarterly Monetary Policy Statement (MPS), together with projections for CPI inflation and GDP growth. The RBNZ only publishes a point forecast, without uncertainty bands. In addition the RBNZ provides a qualitative assessment of the main risks and uncertainties surrounding the forecast. Since the MPS of June 2003, the

RBNZ has published its last projection together with its new one.

The main tool used to produce the forecasts is the RBNZ's core macroeconomic model, where the policy rate is set according to a forward-looking Taylor rule. Interest rate forecasts are conditional on the RBNZ's projections of future inflation. Finally, the model-based forecasts are subjected to policymakers' judgment before ultimately being released in the MPS. The start date for our analysis of New Zealand is March 1999, when the RBNZ adopted the Official Cash Rate (OCR) system. This change basically meant a switch from implementing policy via controlling the quantity of settlement cash, to implementation by controlling the interest rate on settlement cash. The operating procedures of the RBNZ have remained broadly unchanged since then, but the RBNZ raised its inflation target from 1.5% to 2% in the fourth quarter of 2002.[5]

2.2 Norges Bank

Three times a year, usually in March, June and October, Norges Bank publishes its Monetary Policy Report (MPR). Since 2005, the report has contained Norges Bank's forecasts of the sight deposit interest rate, CPI inflation, the output gap, and CPI inflation excluding taxes and energy prices, for each quarter up to 12–15 quarters ahead.[6] The sight deposit rate is the interest rate on banks' deposits in Norges Bank, and is Norway's key policy rate. The objects being forecast are quarterly averages, and point forecasts are published with uncertainty bands around them.

Norges Bank's main tool for producing interest rate forecasts is its core macroeconomic model, combined with judgment. The model-generated forecasts are conditional on key macroeconomic projections, various exogenous variables (e.g., government spending, oil investments) and financial market information, and are derived under the condition that the interest rate is set to minimize a loss function over macroeconomic outcomes. The loss function has regularly been published in the MPRs, and the macroeconomic arguments reported have typically been inflation, the output gap, and past interest rates. As stated in the MPRs, the loss function is meant to capture Norges Bank's three criteria for an "appropriate" interest rate forecast: 1) achievement of the inflation target; 2) a reasonable balance between inflation and capacity utilization; 3) robustness. Finally, the Executive

Board decides on the likely interval for the policy rate over the next three months (the "strategy interval"), and the staff produces a forecast for the interest rate path.[7]

3 Econometric Specification

In this section we derive a flexible formulation of monetary policy to be estimated, describe the data to be used in the estimation, and explain the estimation strategy.

3.1 Deriving the Reaction Function

Consider a central bank that in every period t sets the current interest rate i_t and announces a future path for that rate.[8] The path consists of two interest rate forecasts: a short-horizon forecast $i^p_{t,t+s}$ (e.g., one-quarter-ahead) and a long-horizon forecast $i^p_{t,t+l}$ (e.g., two-quarters-ahead). By assuming two forecasts only, we keep the exposition simple while capturing the feature that every path presents interest rate forecasts for different time horizons.

The policymaker discounts the future by δ and sets i_t, $i^p_{t,t+s}$ and $i^p_{t,t+l}$ to minimize the expected discounted sum of future intratemporal losses given by:

$$\mathscr{L}_t = \frac{1}{2} E_t \sum_{k=0}^{\infty} \delta^k \left[\begin{array}{c} \left(i_{t+k} - i^*_{t+k}\right)^2 + \varphi (i_{t+k} - i_{t+k-1})^2 \\ +\kappa_s \left(i_{t+k} - i^p_{t+k-s,t+k}\right)^2 + \kappa_l \left(i_{t+k} - i^p_{t+k-l,t+k}\right)^2 \end{array} \right]. \tag{1}$$

The first term in the loss function represents the costs of deviating from a "target" interest rate i^*_t. The target rate summarizes what the central bank sees as an appropriate interest rate given macroeconomic variables other than its own policy choices – for instance, the interest rate implied by a Taylor rule. As explained below, we will consider a variety of specifications of i^*_t. The second term in the loss function captures the policymaker's preference for interest rate smoothing, and the parameter φ results in policy inertia.

Our key objects of interest are the last two terms in the loss function, where κ_s and κ_l capture the policymaker's preference for adhering to previously announced interest rate forecasts at the long and short horizon. If either weight is positive, the policymaker perceives forecast errors as costly, and has a preference for forecast adherence.

The first-order condition for the optimal interest rate i_t is:

$$\begin{gathered} i_t - i_t^* \\ +\varphi(i_t - i_{t-1}) - \delta\varphi\left(E_t i_{t+1} - i_t\right) \\ +\kappa_s\left(i_t - i_{t-s,t}^p\right) + \kappa_l\left(i_t - i_{t-l,t}^p\right) - E_t\sum_{k=0}^{\infty}\delta^k\left[\left(i_{t+k} - i_{t+k}^*\right)\frac{\partial i_{t+k}^*}{\partial i_t}\right] = 0. \end{gathered} \tag{2}$$

The last term, $E_t\sum_{k=0}^{\infty}\delta^k[\bullet]$, reflects how deviations from the target rate might affect the target rate itself via the macroeconomic variables that i_t^* responds to. However, as monetary policy typically influences the economy with a lag, interest rate decisions have a negligible effect on i^* in the short term, i.e. $\frac{\partial i_{t+k}^*}{\partial i_t} \approx 0$ when k is small. Moreover, for longer horizons the actual policy rate will typically converge to the target rate. Hence, as an approximation, the product $E_t\left(i_{t+k} - i_{t+k}^*\right)\frac{\partial i_{t+k}^*}{\partial i_t} \approx 0$ for all $k = 1, 2, ..., T$, and the discounted sum of these products is likely to be negligible. Imposing this approximation and solving equation (2) for the current interest rate yields the following reaction function:

$$i_t = \Omega\left[i_t^* + \varphi i_{t-1} + \delta\varphi E_t i_{t+1} + \kappa_s i_{t-s,t}^p + \kappa_l i_{t-l,t}^p\right], \tag{3}$$

where $\Omega = \frac{1}{1+\varphi(1+\delta)+\kappa_s+\kappa_l}$ determines how strongly i_t responds to changes in the macroeconomic environment. We see that a reluctance to deviate from previously published interest rate forecasts, meaning that κ_s or κ_l is positive, reduces this responsiveness in a similar way as the interest rate smoothing parameter φ does. We also see that the preference for interest rate smoothing, φ, implies partial adjustment to anticipated future policy as well as adjustment to the lagged policy rate, as emphasized by Bache, Røisland, and Torstensen (2011).

3.2 Policy Rules and Data

The main challenge for identifying our coefficients of interest in equation (3), κ_s and κ_l, is to measure the target rate i_t^*. Our approach will be to consider alternative formulations of i_t^*, based on the available documentation provided by the two central banks and the literature on simple policy rules.

For the RBNZ, we start with an institution-specific formulation of the target rate based on the policy rule in the latest documentation of the RBNZ monetary policy model, the "K.I.T.T." model, as given by Benes, Binning, Fukac, Lees, and Matheson (2009):

$$i_t^* = \gamma^{\pi}\left(E_t\pi_{t+j} - E_t\overline{\pi}_{t+j}\right), \tag{4}$$

where $E_t\pi_{t+j}$ is expected future inflation at horizon j and $E_t\overline{\pi}_{t+j}$ is the inflation target. The terms on the right-hand side are demeaned. For inflation expectations, we use the RBNZ survey of two-year-ahead inflation expectations, hence $p = 8$. The reason is that Monetary Policy Statement reports headline inflation forecasts, and therefore RBNZ's one-quarter-ahead inflation expectations $E_t\pi_{t+1}$ are noisy and known to carry little weight in estimated policy rules for New Zealand; see for instance Kendall and Ng (2013).[9]

For Norges Bank, we consider an institution-specific target rate based on Bernhardsen (2008), who argues that the following formulation is both policy-relevant and fits the historical record well:

$$i_t^* = \gamma^{\pi}\pi_t + \gamma^{int} i_t^{int} + \gamma^{w} w_t + \gamma^{y} y_t. \tag{5}$$

Here π_t is core inflation, and the series is constructed by averaging monthly year-on-year CPI inflation adjusted each quarter for energy and taxes. The series is seasonally adjusted. Next, i_t^{int} is the quarterly average of the trade-weighted international interest rates index. The third variable, w_t, is the quarterly averaged year-on-year wage growth in Norway generated by NEMO, the macroeconomic model used by the Norges Bank for policy making. Finally, y_t is the quarterly average output gap from NEMO. This output gap is constructed by deducing potential growth, as determined by NEMO, from Norges Bank's mainland GDP growth forecast, as published in the Monetary Policy Report. The wage growth series is not measured in real time, but all the other variables on the right-hand side of equation (5) are measured as they were available when the actual policy rate decisions were made, following the lead of Orphanides (2001). This detail might be particularly important for our purposes, as the published interest rate forecasts added to the rules are real-time variables.

In addition to the institution-specific formulations in equations (4) and (5), we use the extended Taylor rule of Clarida, Galí, and Gertler (1999) ("CGG rule" hereafter) and the "Calvo rule" of Levine, McAdam, and Pearlman (2007) for both countries. In the CGG rule, the target rate is determined by expected inflation and the expected output gap. For New Zealand, we continue using the aforementioned two-year-ahead inflation expectations from the RBNZ survey, while for Norway, we use Norges Bank's one-period-ahead forecast of the CPI index adjusted for energy and taxes. For expected output gaps we use the two Cental Banks' one-quarter ahead forecasts. All numbers are obtained from the two countries' monetary policy reports. The Calvo rule is a specification where the expected future interest rate, $E_t i_{t+1}$, enters the explanatory variables as in equation (3). The motivation behind this extension is not just that the central bank might have a preference for interest rate smoothing as emphasized in the derivation of equation (3), but also that a central bank might react to the entire discounted sum of expected future inflation rates, which can be captured by including $E_t i_{t+1}$, as emphasized by Levine, McAdam, and Pearlman (2007).

As explained in Section 2, Norges Bank announces its interest rate forecasts only three times a year, namely in March, June, and October. Since we use quarterly data in our estimation, we must account for the fact that the two-quarter-ahead forecast published in June is the last preceding forecast for quarter four, and that the three-quarter-ahead forecast from June is the second-last forecast for quarter one. This issue does not arise for the RBNZ since forecasts are quarterly, but instead we must address the fact that the object being forecast is the Bank Bill rate, not the policy rate. To deal with this issue, we subtract the realized (quarterly averaged) spread from each interest rate forecast.

3.3 Estimation

Based on the above considerations, we estimate alternative versions of the following equations for New Zealand and Norway, respectively:

$$i_t = \Omega \left[\begin{array}{c} \gamma^{\pi}(E_t\pi_{t+8} - E_t\overline{\pi}_{t+8}) + \gamma^{y} E_t y_{t+1} \\ +\varphi i_{t-1} + \delta\varphi E_t i_{t+1} + \kappa_s i^p_{t-1,t} + \kappa_l i^p_{t-2,t} \end{array} \right] + \varepsilon_t, \tag{6}$$

and

$$i_t = \Omega \left[\begin{array}{c} \gamma^{\pi_{t+j}} E_t\pi_{t+j} + \gamma^{int} i^{int}_t + \gamma^{w} w_t + \gamma^{y_{t+j}} y_{t+j} \\ +\varphi i_{t-1} + \delta\varphi E_t i_{t+1} + \kappa_s i^p_{t-1,t} + \kappa_l i^p_{t-2,t} \end{array} \right] + \varepsilon_t, \tag{7}$$

where $j = 0$ or $j = 1$, and $\Omega = \frac{1}{1+\varphi(1+\delta)+\kappa_s+\kappa_l}$ as before.

We also estimate the different versions of equations (6) and (7) in reduced form. Generally formulated, the reduced form equation for New Zealand is

$$\begin{aligned} i_t &= \xi^{\pi} E_t(E_t\pi_{t+8} - E_t\overline{\pi}_{t+8}) + \xi^{y} E_t y_{t+1} \\ &\quad + \xi^{\varphi} i_{t-1} + \xi^{\delta} E_t i_{t+1} + \xi^{s} i^p_{t-s,t} + \xi^{l} i^p_{t-l,t} + \varepsilon_t, \end{aligned} \tag{8}$$

whereas for Norway it reads

$$\begin{aligned} i_t &= \xi^{\pi_{t+j}} E_t\pi_{t+j} + \xi^{int} int_t + \xi^{w} w_t + \xi^{y} E_t y_{t+1} \\ &\quad + \xi^{\varphi} i_{t-1} + \xi^{\delta} E_t i_{t+1} + \xi^{s} i^p_{t-s,t} + \xi^{l} i^p_{t-l,t} + \varepsilon_t. \end{aligned} \tag{9}$$

When estimating equations (6) to (9), we will attempt to distinguish between policy inertia, i.e. the preference for interest rate smoothing, and persistence of the unexplained policy component, ε_t. To this end, we follow Rudebusch (2002) and maximize the appropriate likelihood function where the error term is modeled as an AR(1) process:[10]

$$\varepsilon_t = \lambda\varepsilon_{t-1} + \zeta_t \qquad \zeta_t \sim i.i.d.N(0, \sigma^{\zeta}). \tag{10}$$

Announced forecasts are highly collinear with the lagged policy rate. To see if the forecasts add incremental value, we use residuals from the following regression, instead of the original forecast series, in the interest rate rules we estimate:

$$i^p_{t,t+h} = \beta_0 + \beta_1 i_{t-1} + \varepsilon^{p,h}_t \ . \tag{11}$$

Due to this *orthogonalization*, the forecast variables added to the different rules include only information beyond the general level of interest rates. When the original forecast series are included in interest rate rules, the lagged policy rate, and not the forecasts, becomes insignificant due to collinearity.[11]

4 Results

We estimate both the structural and the reduced-form parameters, κ_j and ξ^j for $j = s, l$. We first include only the most recently announced interest rate path, $j = s$. Thereafter, we estimate reaction functions where both the most recent and the older interest rate forecasts enter as arguments. Finally, we scrutinize the interpretation of these results by estimating reaction functions that control for a set of additional control variables, and by studying the reaction to market forecasts before and after Norges Bank began publishing its interest rate paths.

4.1 Estimated Reaction Functions

We discuss the estimated reaction functions for each country separately.

4.1.1 RBNZ

Table 2 shows our results for New Zealand. The t-statistics are reported in brackets, calculated using bootstrapping.[12]

TABLE 2 ABOUT HERE

The main message from Table 2 is that across the three specifications, the estimated coefficients on the most recent interest forecast, κ_s and ξ^s, are positive and statistically significant. Only when using the Calvo rule does significance of the adherence estimate drop below 5 percent, reflecting high collinearity between the last announced interest rate forecast and the expected future interest rate. Focusing on the reduced-form estimates of the CGG rule, the coefficient on adherence is slightly higher than the coefficient on the inflation rate. The relative magnitudes of the deep parameter estimates differ from the reduced-form estimates because the deep parameters are constrained in the estimation procedure. Inspecting the deep parameters, we see that the adherence estimate is about half of the estimated coefficient on inflation.

To illustrate the quantitative importance of the estimated adherence terms, Figure 1 presents the in-sample fit for the estimated CGG rule. We compare this rule's predictions when all the coefficients are as reported in Table 2 to the predictions when $\kappa_s = 0$ and all other parameter values are unchanged. In the bottom panel, the realized policy rate is represented by dots, the solid line is the interest rate predicted by the CGG rule using the past interest rate forecasts, and the dashed line is the model-implied rate with $\kappa_s = 0$. The distance between the dashed and the solid line therefore quantifies the contribution of adherence at any point in time. The upper panel plots the residuals from the CGG rule including forecast adherence (solid line) and residuals when $\kappa_s = 0$ (dashed line). Hence, the difference between the two indicates how much the estimated forecast adherence contributed to explaining policy in the sample. We see that the estimated adherence plays a role over the entire sample period, as the residuals are reduced in the model with forecast adherence throughout. Moreover, the residuals imply that adherence has frequently influenced policy by 25 basis points, and sometimes by as much as 50 basis points.

FIGURE 1 ABOUT HERE

4.1.2 Norges Bank

Table 3 presents results from Norges Bank's estimated reaction functions.

TABLE 3 ABOUT HERE

All specifications yield estimates of κ_s and ξ_t that are positive, consistently with the hypothesis that Norges Bank adhered to its one-quarter-ahead interest rate forecasts, but the t-statistics indicate significance for only 3 out of the 6 cases.

With the CGG rule, the estimated adherence parameters are approximately half as large as the coefficient on inflation, while for the two other rules the adherence and inflation point estimates lie somewhat closer to each other.

As we did for New Zealand, we assess the quantitative importance of our results by plotting the in-sample performance of the CGG-based estimates. Figure 2 implies that for the first years in our sample, adherence did not play a big role, as the estimated rule fits actual policy decisions slightly better with the coefficient on interest paths set to zero. However, from 2007 onwards, old forecasts consistently seem to have played a role for current policy decisions, quite frequently by 25 basis points, sometimes even more.

4.1.3 Longer-Horizon Forecasts

In the regressions reported above we only controlled for the last published forecast. We next include older forecasts for the current period as well. Table 4 in the appendix reports the results when both one-quarter-ahead ($s = 1$), and two-quarters-ahead ($l = 2$) forecasts are controlled for in the estimating equations (6) to (10). For space considerations we only report the coefficients on the interest rate paths from the CGG-specifications, which include expected inflation, expected output gap, and the past interest rate. The alternative specifications give similar results.

We see that in both countries only the latest interest rate forecast receives a positive coefficient. Though not reported here, we reach the same finding when controlling for forecasts that are three to eight quarters old. Moreover, if we exclude the most recent forecast, then the older forecasts are statistically significant, reflecting the correlation of interest rate paths over time.

Hence, once the most recent forecast is controlled for, earlier forecasts do not seem to matter for current policy. This finding is intuitively reasonable. The costs of deviating from a pre-announced plan are most likely sunk once the plan is revised for the first time, and hence there is no reason to emphasize forecasts that are older than the most recent one.

4.2 Additional Control Variables

While our estimates are consistent with the adherence hypothesis, it is natural to ask if they are driven by omitted variables. Any policy rule will be misspecified by not adequately capturing exactly what policymakers had in mind at every point in time, and decisions regarding the appropriate policy rate can be systematically influenced by omitted factors such as financial market conditions or policymakers' judgment. Our use of past and future policy rates is likely to mitigate this problem, but misspecification could still be driving our main results.

A direct way to assess the omitted variable problem, is to control for candidate variables that might be correlated with both past central bank paths and with the current interest rate decisions. The variables we consider are an interest rate spread, credit growth, house price growth, stock prices, realized volatility, consumer and industry confidence indices, a leading indicator of global economic activity, the Fed Funds rate, the implied US stock market volatility index (VIX), and a global commodity index. For each of these control variables, we run a separate regression, where the additional control is included in the CGG specification we considered above, which included past rates, the inflation rate and output, as well the past interest rate path. All the new controls cannot be included at once due to limited sample sizes. The specification we estimate is

$$i_t = \xi^{\pi} E_t \pi_{t+j} + \xi^{y} E_t y_{t+1} + \xi^{\varphi} i_{t-1} + \xi^{x} x_t + \xi^{s} i^{p}_{t-s,t} + \varepsilon_t, \tag{12}$$

where x_t is one of the additional control variables listed above, $j = 8$ for New Zealand and $j = 1$ for Norway, and ε_t is modeled according to (10).

Results with the additional control variables are reported in Table 5. For each country, the first column reports point estimates for the additional control (ξ^x), and the second column reports the estimate for the most recent interest rate forecast (ξ^s). We see that the point estimates of the forecast coefficient are fairly stable across specifications, ranging from 0.39 to 0.53 in New Zealand and from 0.26 to 0.38 in Norway. The t-statistics are always quite high.[13]

4.3 Central Bank Forecasts versus Market Forecasts

Svensson (2003) and Rudebusch (2006) discuss how central banks may be averse to surprise markets. Our estimates of forecast adherence are likely to capture such a surprise aversion. While forecast adherence and surprise aversion are conceptually distinct, they are not straightforward to separate empirically. A central bank that aims to avoid surprises will *de facto* stick to its own forecasts, if these forecasts are consistent with market expectations. Vice versa, a central bank that prefers adherence to its own forecasts will de facto avoid market surprises. If central banks publish their forecasts, these two forces are complementary and mutually re-inforcing.

However, for Norway we may illuminate the role of surprise aversion by separately estimating interest rate rules before and after Norges Bank started to publish its own interest rate forecasts in November 2005. This is possible because the period around 2005 was one of stability in terms of the monetary policy regime, apart from the introduction of interest rate paths. As explained in Section 2.1, the RBNZ changed its operating procedures fundamentally in March 1999, after it had introduced interest rate paths in 1997. Hence, for New Zealand any differences in estimated reaction functions before and after 1997 could equally well reflect the entirely different policy regimes in place as it could reflect the introduction of interest rate paths.

We estimate different versions of the following equation for Norway:

$$i_t = \xi^{\pi} E_t \pi_{t+1} + \xi^{y} E_t y_{t+1} + \xi^{\varphi} i_{t-1} + \xi^{fwd} i^{m}_{t-1,t} + \xi^{s} i^{p}_{t-s,t} + \varepsilon_t, \tag{13}$$

with ε_t modelled according to (10).

The pre-path sample starts in 1999, as this is when Norges Bank introduced inflation targeting in practice. We approximate market expectations with the three-month forward rate. If the estimated adherence coefficients in Table 3 are solely driven by surprise aversion, or omitted variables correlated with Norges Bank forecasts in general, then this should also generate significant estimates for market forecasts.

Table 6 reports the results from this exercise, controlling for inflation and output as in the CGG rule. The first column shows that the weight on market forecasts is significant when estimated over the pre-2005 period. This is consistent with surprise aversion. The second column shows that the point estimate of the adherence coefficient is larger over the period with published interest rate paths. This is consistent with a mutually re-inforcing role of surprise aversion and forecast adherence. The third column shows that once Norges Bank's interest rate forecasts are controlled for, the estimated weight on market forecasts is no longer significantly positive, which might reflect that the estimate in column 2 is driven by correlation with the published interest rate paths.[14]

These results do not preclude the possibility that the central bank forecasts could be proxying for omitted variables, or that they are averse to surprising markets. But they do indicate that our estimated weights on past interest paths in Tables 2 and 3 are not only reflecting omitted variables that correlate with interest rate forecasts in general. If omitted variables are driving our results, they must be more strongly correlated with the central bank's interest rate paths than with the market forecasts after 2005, and they must be weaker correlated with interest rate decisions before than after 2005, which limits the omitted variable problem somewhat. Still, the misspecification issue will always remain a valid critique of estimated simple rules, and one should therefore be cautious in interpreting our specific coefficient estimates as pinning down the quantitative, causal, effect of adherence to interest rate paths alone.

5 Conclusion

The practice of explicitly announcing future monetary policy intentions has been widely recommended in the theoretical literature and increasingly implemented by central banks. Our findings indicate that the RBNZ and Norges Bank, the two central banks with the longest history of publishing interest rate forecasts, might have placed some weight on their last published interest rate projections when setting the current interest rate level.

On the empirical side, one might reasonably question whether our estimates reflect a causal effect or just that past forecasts proxy for omitted variables. We have dealt with this issue by directly controlling for the most obvious variables that could have played a role in generating our findings, and by studying the reaction to market interest forecasts as inferred from forward rates. These robustness tests do not overturn our main findings. However, pursuing this question with further alternative approaches would be valuable.

Normatively, the question of whether forecast adherence is beneficial remains open. Adherence might indicate that policymakers are averse to surprising markets, or that they use published interest rate paths as a commitment device, as in Odyssean forward guidance, to increase policy effectiveness. However, a reluctance to deviate from past forecasts might also prevent policymakers from reacting sufficiently strongly to unexpected shocks. Addressing these arguments requires further theoretical and empirical work.

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Notes

[1]See Eggertsson and Woodford (2004) and Woodford (2005).

[2]In 1997 the Reserve Bank of New Zealand introduced the practice of publishing their own interest rate forecasts, followed in 2005 by Norges Bank, Sweden's Riksbank and the Central Bank of Iceland in 2007, the Czech National Bank in 2008, and the Federal Reserve in 2012.

[3]See, for instance, Svensson (2009), Mishkin (2004), Goodhart (2009) and Kohn (2008) for the early debate on publishing interest rate paths. Another contested issue concerns the merits of informing private agents about the central bank's reaction pattern; see for example Morris and Shin (2002), Svensson (2006), Gosselin, Lotz, and Wyplosz (2008) and Rudebusch and Williams (2008).

[4]We cannot conduct this exercise for the RBNZ, since its operational procedures were significantly changed in March 1999, when the practice of publishing interest rate forecasts was already in place.

[5]For documentation of RBNZ's core model, see Benes, Binning, Fukac, Lees, and Matheson (2009). For a discussion of the use of judgment, the treatment of uncertainty and the procedure behind interest rate forecasts, see Drew and Karagedikli (2008) and Ranchhod (2002). Details on the 1999 change in policy implementation are given in Archer, Brookes, and Reddell (1999).

[6]As of 2013, Norges Bank publishes its path four times a year. Forecast horizons vary somewhat across reports, between 12 and 15 quarters.

[7]For documentation of Norges Bank's core model, see Brubakk, Husebø, Maih, Olsen, and Østnor (2006). For a discussion of the use of judgment, uncertainty bands, and further details on the policy process, see Holmsen, Qvigstad, Røisland, and Solberg-Johansen (2008) and Alstadheim, Bache, Holmsen, Maih, and Røisland (2010).

[8]Our derivation of a testable policy formulation follows the same steps as Bache, Røisland, and Torstensen (2011) utilize in a study of interest rate smoothing.

[9]We thank Ashley Lienert from the RBNZ for providing the data.

[10] A standard line-search algorithm is used where the descent direction is calculated using the quasi-Newton method.

[11] In all the augmented specifications we estimate for the RBNZ, we constrain the coefficient φ in front of the lagged policy rate to be equal to its value from the corresponding rule estimated without interest rate forecasts. Without the constraint, the algorithm does not converge to a finite solution.

[12] Because we include a regression residual in our estimation, we use bootstrapping to construct standard errors. Our procedure is as follows. We sample data points with replacement where each observation in period t contains current and lagged values of all the variables entering the rule. For instance, with the CGG-policy rule these would be: $\left(i_{t-1}, i^{p}_{t-s,t}, i_t, E_t\pi_{t+1}, E_t y_{t+1}\right)$. We form bootstrapped samples of length equal to 50 for the RBNZ and 25 for the NB. We then perform our two-step procedure, i.e. estimate equation (11) and use the residuals as the explanatory variable in the rule. Finally, the standard errors are calculated from coefficient estimates of 10,000 bootstrapped samples.

[13] In addition to the robustness tests reported here, we have gauged the misspecification issue by simulating a basic New Keynesian model solved under optimal policy with alternative weights on forecast errors in the policymaker's loss function, as in Gersbach and Hahn (2011). When our simple rules are estimated on these artificial data, the estimated coefficient on past forecasts is significant only if the policymaker's preference for adherence is sufficiently strong. Results are found in an earlier version of this paper, available on the authors' web pages.

[14] Note that the results in column 3 should be treated with caution, as the forward rate and central bank forecasts are extremely highly correlated.

Figures and Tables

Table 1: Interest Rate Forecast Publication Dates

Quarter	RBNZ	NB
1Q-1999	17-03-1999	
2Q-1999	19-05-1999	
3Q-1999	18-08-1999	
4Q-1999	17-11-1999	
1Q-2000	15-03-2000	
2Q-2000	17-05-2000	
3Q-2000	16-08-2000	
4Q-2000	06-12-2000	
1Q-2001	14-03-2001	
2Q-2001	16-05-2001	
3Q-2001	15-08-2001	
4Q-2001	14-11-2001	
1Q-2002	20-03-2002	
2Q-2002	15-05-2002	
3Q-2002	14-08-2002	
4Q-2002	20-11-2002	
1Q-2003	06-03-2003	
2Q-2003	05-06-2003	
3Q-2003	04-09-2003	
4Q-2003	04-12-2003	
1Q-2004	11-03-2004	
2Q-2004	10-06-2004	
3Q-2004	09-09-2004	
4Q-2004	09-12-2004	
1Q-2005	10-03-2005	
2Q-2005	09-06-2005	
3Q-2005	15-09-2005	
4Q-2005	08-12-2005	02-11-2005
1Q-2006	09-03-2006	16-03-2006
2Q-2006	08-06-2006	29-06-2006
3Q-2006	14-09-2006	
4Q-2006	07-12-2006	01-11-2006
1Q-2007	08-03-2007	15-03-2007
2Q-2007	07-06-2007	27-06-2007
3Q-2007	13-09-2007	
4Q-2007	06-12-2007	31-10-2007
1Q-2008	06-03-2008	13-03-2008
2Q-2008	05-06-2008	25-06-2008
3Q-2008	11-09-2008	
4Q-2008*	04-12-2008	29-10-2008
		17-12-2008
1Q-2009	12-03-2009	25-03-2009
2Q-2009	11-06-2009	17-06-2009
3Q-2009	10-09-2009	
4Q-2009	10-12-2009	28-10-2009
1Q-2010	11-03-2010	24-03-2010
2Q-2010	10-06-2010	23-06-2010
3Q-2010	16-09-2010	
4Q-2010	09-12-2010	27-10-2010
1Q-2011	10-03-2011	16-03-2011
2Q-2011	09-06-2011	22-06-2011
3Q-2011	15-09-2011	
4Q-2011	08-12-2011	19-10-2011

*Note: * Norges Bank published interest rate forecasts twice during the fourth quarter of 2008.*

Table 2: Policy Rules for the RBNZ with One-Quarter-Ahead Interest Rate Forecasts ($\mathbf{s = 1}$)

	Deep Parameters				Reduced-Form Parameters		
	KITT	CGG	Calvo		KITT	CGG	Calvo
γ^{π}	4.246*	4.936**	3.712**	ξ^{π}	0.025	0.364	-0.122
	(2.032)	(2.698)	(2.689)		(0.115)	(1.337)	(-1.052)
γ^{y}		0.604	0.545*	ξ^{y}		0.149**	-0.049^{*}
		(1.843)	(2.245)			(3.135)	(-2.251)
φ	2.233	3.021	1.879	ξ^{φ}	0.888**	0.809**	0.987**
	—	—	—		(14.867)	(11.972)	(23.212)
δ			0.471	ξ^{δ}			0.784**
			(1.817)				(11.686)
κ_s	1.643**	1.954**	0.597	ξ^{s}	0.621**	0.487**	0.107
	(4.836)	(5.014)	(1.209)		(3.945)	(3.703)	(1.889)
λ	0.973**	0.938**	0.970**	λ	0.244	0.229	0.548**
	(6.608)	(6.224)	(6.110)		(1.612)	(1.475)	(3.262)
DW	1.566	1.750	1.252	DW	1.810	1.797	1.873

Note: Deep parameters estimated from equations (6) and (10). Reduced-form parameters estimated from equations (8) and (10). Column KITT refers to a specification motivated by RBNZ documentation with lagged interest rates and expected inflation. Column CGG refers to a specification with output gap, expected inflation and lagged interest rates. Column Calvo refers to a specification with expected inflation, output gap, and lagged and future interest rates. The t-statistics (in brackets) are calculated using bootstrapped standard errors and the last row reports the Durbin-Watson statistic (DW). The t-statistic on φ is missing because this parameter is constrained to equal its value from an estimation without the RBNZ forecast. The number of observations is 50. $*$ implies significance at the 5% level, $**$ implies significance at the 1% level.

Table 3: Policy Rules for the Norges Bank with One-Quarter-Ahead Forecasts ($\mathbf{s=1}$)

	Deep Parameters				Reduced-Form Parameters		
	B	CGG	Calvo		B	CGG	Calvo
γ^{π_t}	0.494			ξ^{π_t}	0.205		
	(1.859)				(2.027)		
$\gamma^{\pi_{t+1}}$		1.628^{**}	0.506^{*}	$\xi^{\pi_{t+1}}$		0.504^{**}	0.135
		(4.115)	(2.743)			(3.322)	(0.989)
γ^{int}	0.222		0.471^{**}	ξ^{int}	0.092		0.356^{**}
	(0.030)		(3.761)		(0.768)		(3.148)
γ^{w}	1.235		1.398^{**}	ξ^{w}	0.513^{*}		-0.125
	(0.090)		(4.839)		(2.447)		(-0.651)
γ^{y}	0.360	1.332^{**}	0.027	ξ^{y}	0.150	0.413^{**}	0.084
	(0.062)	(4.489)	(0.146)		(0.916)	(4.358)	(0.515)
φ	0.618	1.372	0.584^{**}	ξ^{φ}	0.257	0.425^{**}	0.549^{**}
	(0.039)	(1.650)	(5.861)		(1.421)	(2.982)	(3.396)
δ			0.305	ξ^{δ}			0.248
			(0.006)				(1.221)
κ_s	0.789	0.855	0.785^{*}	ξ^{s}	0.328^{*}	0.265^{*}	0.207
	(0.055)	(1.290)	(2.839)		(2.801)	(2.566)	(0.495)
λ	0.404	0.144	0.212	λ	0.404	0.144	0.847^{*}
	(1.347)	(0.540)	(0.654)		(0.583)	(0.542)	(2.469)
DW	1.870	1.921	1.955	DW	1.870	1.490	2.310

Note: Deep parameters estimated from equations (7) and (10). Reduced-form parameters estimated from equation (9) and (10). Column B refers to a specification motivated by Norges Bank documentation with lagged interest rates, and current inflation, output gap, wage growth and foreign interest rates. Column CGG refers to a specification with output gap, expected inflation and lagged interest rates. Column Calvo refers to a specification with expected inflation and output gap, current wage growth and foreign interest rates, and lagged and future interest rates. The t-statistics (in brackets) are calculated using bootstrapped standard errors and the last row reports the Durbin-Watson statistic (DW). The number of observations is 25. $*$ implies significance at the 5% level, $**$ implies significance at the 1% level.

Table 4: Adding Longer-Horizon Forecasts

	Deep Parameters			Reduced-Form Parameters	
	RBNZ	NB		RBNZ	NB
κ_s	1.828*	1.089	ξ^s	0.721*	0.302
	(2.604)	(1.835)		(2.441)	(1.406)
κ_l	-1.007	-0.280	ξ^l	-0.255	-0.078
	(-1.529)	(-0.418)		(-1.114)	(-0.359)
λ	0.893	0.172	λ	0.080	0.172
	(1.858)	(0.885)		(0.143)	(0.584)
DW	1.881	1.929	DW	1.956	1.572

Note: Estimated coefficients on interest rate forecasts in specifications (6) to (9), always using (10). The CGG-versions of the specifications, which include expected inflation, expected output and the lagged interest rate, are always used. The short-horizon forecast is $s = 1$ (3 months) and the longer-horizon forecast is $l = 2$ (six months). The t-statistics (in brackets) are calculated using bootstrapped standard errors and the last row reports the Durbin-Watson statistic (DW). $*$ implies significance at the 5% level, $**$ implies significance at the 1% level.

Table 5: Additional Controls

	RBNZ		NB	
x_t	ξ^x	ξ^s	ξ^x	ξ^s
Mortgage rate minus policy rate	0.049	0.501^{**}	-0.277	0.295^{*}
	(0.345)	(3.835)	(-1.165)	(2.660)
Credit growth (% q/q)	0.107	0.483^{**}	-0.001	0.262
	(1.485)	(3.704)	(-0.107)	(1.940)
House prices (% q/q)	0.008	0.488^{**}	-0.025	0.259^{*}
	(0.300)	(3.524)	(-1.529)	(2.557)
Stock prices (% q/q)	0.010	0.495^{**}	0.009	0.381^{*}
	(0.807)	(3.810)	(1.645)	(3.290)
Realized volatility	-15.667	0.492^{**}	-3.471	0.326^{*}
	(-0.346)	(3.765)	(-1.663)	(3.277)
Consumer confidence (% q/q)	0.003	0.499^{**}	0.000	0.263
	(0.359)	(3.741)	(0.049)	(2.062)
Industrial confidence	0.001	0.490^{**}	0.000	0.265^{*}
	(0.200)	(3.554)	(1.964)	(2.853)
Global leading indicator (% q/q)	0.324^{**}	0.532^{**}	0.126	0.360^{**}
	(3.081)	(4.805)	(1.667)	(3.165)
Fed funds rate	0.111^{**}	0.388^{**}	0.002^{*}	0.258^{*}
	(3.622)	(3.054)	(2.294)	(2.835)
VIX	-0.018^{*}	0.475^{**}	0.018	0.277^{*}
	(-2.181)	(3.838)	(0.467)	(2.335)
Global commodity index (% q/q)	0.017^{**}	0.513^{**}	0.007	0.349^{**}
	(2.874)	(4.348)	(2.013)	(3.688)

Note: Parameter estimates for the reduced form equation (12) together with (10), with additional controls x_t added separately. Mortgage rates are the "Floating first mortgage new customer housing rate" calculated by the RBNZ and the "Mortgage companies - households - average" calculated by Norges Bank. House prices are captured by the Residential Property Price Index calculated by the Bank of International Settlements. Consumer confidence is the McDermott Miller Index for New Zealand and the TNS Gallup Index for Norway. Industrial confidence index is published by the OECD. Each of these series is downloaded from Datastream. *The remaining series are from* Bloomberg. *Changes in stock prices are calculated using the "New Zealand Exchange Ordinaries All Index" (NZSE) and "Oslo Stock Exchange All Share Index" (OSEAX). Realized volatilities are squared daily returns of the NZSE and OSEAX, summed per quarter. Global leading indicator is a simple average of the OECD leading economic indicators for China, United States, Brazil, Euro area, United Kingdom, Japan and Canada. The remainder are the effective Fed funds rate, the level of the CBOE Volatility Index (VIX) and the S&P Goldman Sachs Commodity Index. T-statisics are reported in brackets.* $*$ *implies significance at the* 5% *level,* $**$ *implies significance at the* 1% *level*

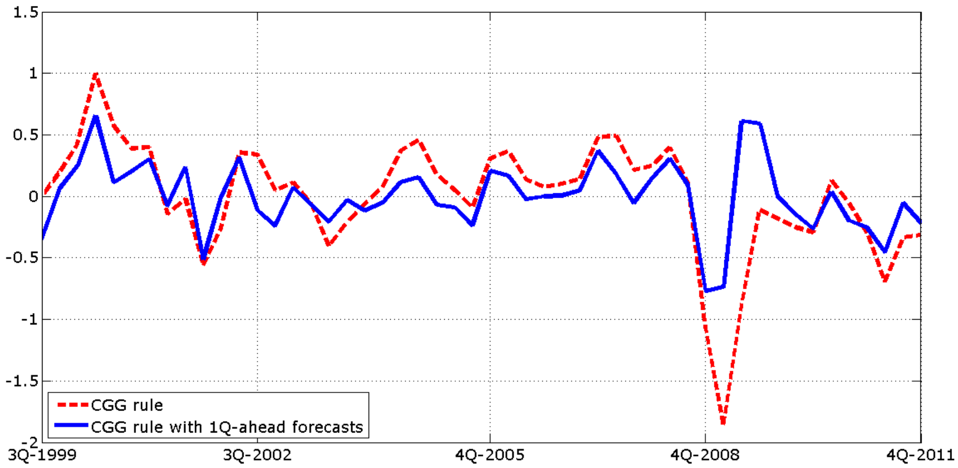
Table 6: Norges Bank Forecasts vs Market Forecasts

	Reduced-Form Parameters		
	1999−2004	2005−2011	2005−2011*
ξ^{π}	0.631^{**}	0.276	0.518^{*}
	(3.151)	(1.024)	(2.625)
ξ^{y}	0.128	0.150	0.108
	(1.031)	(1.447)	(1.431)
ξ^{φ}	0.779^{**}	0.541^{**}	0.715^{**}
	(6.280)	(5.394)	(6.858)
ξ^{fwd}	0.453^{*}	0.810	-0.568^{*}
	(2.319)	(1.931)	(-2.248)
ξ^{s}			0.601^{*}
			(2.444)
λ	0.259	0.881^{**}	0.414
	(-0.215)	(3.448)	(0.609)
DW	1.457	0.269	0.704

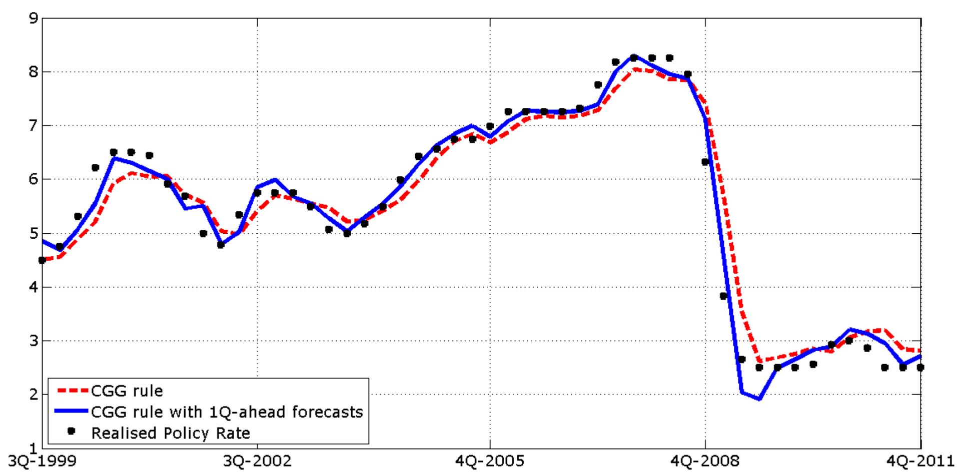
Note: Parameter estimates for the reduced form equation (13) together with (10). The estimated policy rule with the previous three-month market forward rates, as well as expected inflation, output and the lagged policy rate. The first two columns (1999−2004 and 2005−2011) report estimates before and after Norges Bank started publishing policy rate forecasts. The third column (2005−2011) reports estimates controlling for the last one-quarter-ahead Norges Bank forecast. The last row reports the Durbin-Watson statistic (DW).* $*$ *implies significance at the* 5% *level,* $**$ *implies significance at the* 1% *level.*

Figure 1: RBNZ: Quantifying the Importance of Interest Rate Forecasts

A. Residuals



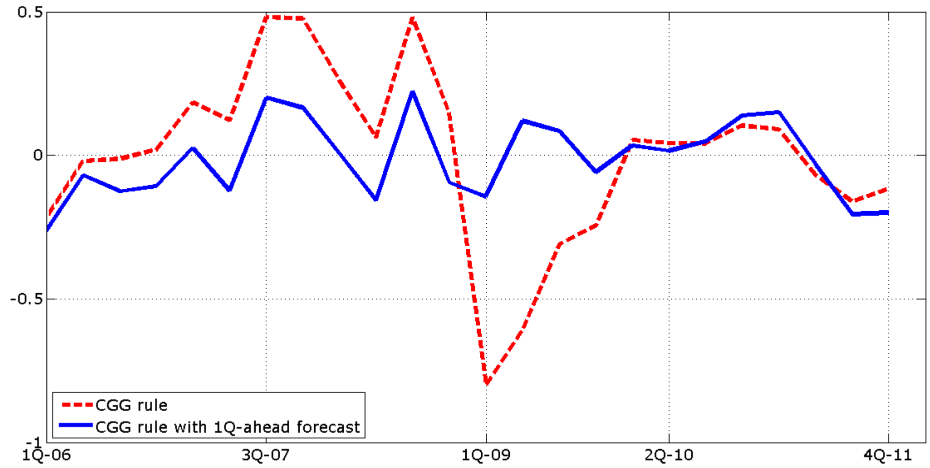
B. Fitted Policy Rates



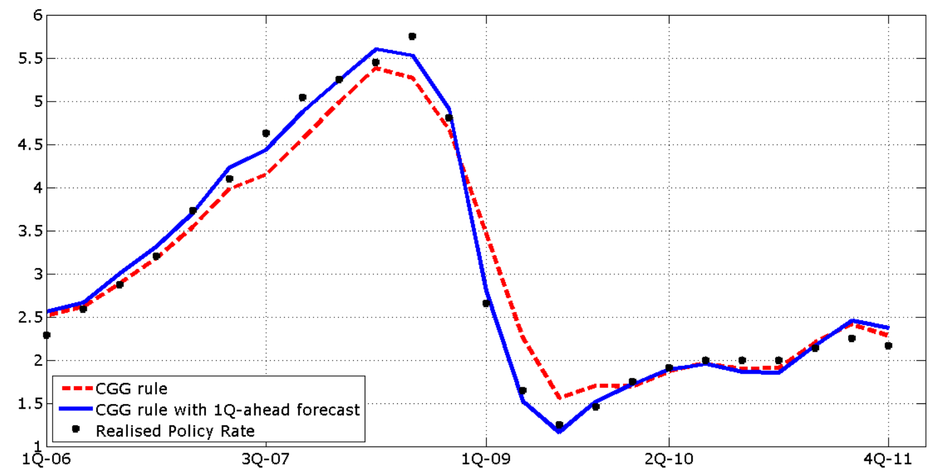
Note: Panel A reports residuals from the estimated CGG-rule with κ_s set to zero (dashed line) together with residuals from the same rule without the restriction (solid line). Similarly, panel B illustrates fitted policy rates with $\kappa_s = 0$ (dashed) and without the restriction (solid line).

Figure 2: Norges Bank: Quantifying the Importance of Interest Rate Forecasts

A. Residuals



B. Fitted Policy Rates



Note: Panel A reports residuals from the estimated CGG-rule with κ_s set to zero (dashed line) together with residuals from the same rule without the restriction (solid line). Similarly, panel B illustrates fitted policy rates with $\kappa_s = 0$ (dashed) and without the restriction (solid line).