Gauging the effectiveness of central bank forward guidance*

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Abstract

This paper conducts a comparative analysis of the performances of the forward guidance strategies adopted by the Reserve Bank of New Zealand, the Norges Bank and the Riksbank, with the aim to gauge whether forward guidance via publication of an own interest rate path enhances a central bank's ability to steer market expectations. Two main results emerge. First, we find evidence that all three central banks have been highly predictable in their monetary policy decisions and that long-term inflation expectations have been well anchored in the three economies, irrespective of whether forward guidance involved publication of an own interest rate path or not. Second, for New Zealand, we find some evidence that a publication of a path can enhance a central bank's leverage on the medium term structure of interest rates.

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1 Introduction

Over the past decade central banks around the world have gradually moved towards establishing more transparency in their conduct of monetary policy, see Dincer and Eichengreen (2007) and Geraats (2008). In particular, increasing emphasis is being given to effective forward guidance on the future path of policy rates. The standard practice amongst central banks is to provide forward guidance via projection or forecast of their goal variables (mainly inflation and real economic growth outlook) and other standard channels, such as press conferences, statements and speeches etc. A few central banks have gone one step further and give quantitative forward guidance by publishing an own projection or forecast of the future path of policy rates. This practice has been pursued by New Zealand since 1997, Norway since 2005 and Sweden since 2007. The perceived primary advantage of publishing an own interest rate path is "*that it makes it easier for the central bank to steer expectations*" (Rosenberg 2007). Indeed, by publishing an own interest rate path, a central bank can in principle steer expectations and thereby enhance the effectiveness of monetary policy in a number of ways:

(i) In steering market expectations of near-term policy rate decisions, publication of an own interest rate path can enhance the predictability of monetary policy, i.e. help avoiding policy surprises and thereby reduce financial market volatility.

(ii) Publishing a policy rate path may help to signal the central bank's commitment to maintain price stability, and thus lead to a better anchoring of long-term inflation expectations.

(iii) Announcing a policy path may enhance the central bank's leverage over medium and longer-term interest rates by enabling it not only to change the current level of policy rates but also to quantitatively signal changes in the prospective future path of policy rates.

These are, in principle, testable hypotheses. (i) implies that monetary policy surprises, i.e. the deviations between the prior market expectation and the outcome of a policy rate decision, are on average smaller when the central bank publishes an interest rate path. (ii) Should imply low responsiveness of longer-term interest rates to incoming macroeconomic news and monetary policy surprises. Finally, (iii) would imply that the central bank can have a stronger influence on medium and longer term yields by being able to quantitatively try to shape market expectations of the future path of policy rates.

The existing empirical literature on the subject, essentially comprises only three papers, namely Archer (2005), Ferrero and Secci (2007) and Moessner and Nelson (2008), focuses on testing hypothesis (iii), i.e. the effect of the publication of a path on the central bank's leverage over financial market interest rates. To this end, the papers try to isolate the surprise in the newly published policy rate

path of the Reserve Bank of New Zealand (RBNZ) and then estimate the effect of this surprise on money market interest rates. The main challenge in doing this is to identify the surprise in the published path, which requires finding a measure of prior market expectations of that path. While market expectations of the future policy rate path can be obtained from implied forward interest rates, a measure of market expectations of the central bank 's own forecast of the interest rate path does not exist and needs to be approximated in some ways, implying a measurement error of unknown severity.

In order to avoid this caveat, this paper takes a different avenue. Using well-established market interest rate-based measures of the surprise component of monetary policy decisions, the above stated hypotheses (i) - (iii) are assessed based on comparative analyses. The main challenge in testing the three hypotheses this way is to design appropriate comparisons in order to be able to assess the incremental effect of communicating policy intentions by means of an interest rate path. One possible way is to compare two central banks which operate under similar monetary policy frameworks but differ in the sense that one of them is publishing a policy rate path and the other not. Another possible way is to compare the performance of one central bank over two different periods in which the policy framework was similar except that a policy rate path was published in one period but not in the other.

In the following we perform both types of comparison. First, a comparative analysis is conducted for the RBNZ and the Swedish Riksbank over the period March 1999 (when the RBNZ switched from an MCI targeting framework to an operational framework centrered on steering the overnight cash rate) till February 2007 (when the Riksbank first published an own interest rate path). Over this sample period the RBNZ regularly published an own interest rate forecast, while the Riksbank published an inflation forecast but not an interest rate forecast. Otherwise both central banks operated under fairly similar conditions and policy frameworks: Both central banks operate in a small open economy environment and have policy frameworks characterised by direct inflation targeting[1] and a high degree of transparency.[2]

Second, we also perform a comparative analysis for the Norges Bank over two different periods, covering the period March 2001 till October 2005 and the period November 2005 till June 2007. The start and end points of the two samples are

[1] The Reserve Bank of New Zealand's inflation target is currently specified as a range for annual CPI inflation of 1-3% over the medium term. Before September 2002 the range was 0-3%. The Riksbank's inflation target is an annual change in the consumer price index (CPI) of around 2 per cent per year, with a tolerance range of plus/minus 1 percentage point.

[2] Quantitative indicators of central bank transparency (e.g. Dincer and Eichengreen (2007) and Eijffinger and Geraats (2006)) commonly characterise the RBNZ and the Riksbank as being among the most transparent central banks in the world

determined by the Norges Bank's switch from exchange rate to inflation targeting in March 2001[3], the first publication of an own policy rate forecast (in addition to the inflation forecast) in November 2005 and the outbreak of the global financial turmoil in June 2007. As described in more detail below we derive monetary policy surprises from money market interest rates. As the financial market turmoil led to an unprecedented increase in the level and the volatility of risk premia in money market rates from July 2007, these rates became an unreliable gauge of market expectations of future policy rates.

The empirical analysis of the paper is based on daily data and focuses on monetary policy "news" or "surprises", i.e. the unexpected part of an announced change in the monetary policy stance. The focus on the surprise components is motivated by the insight that financial asset prices are forward-looking and should therefore only respond to unexpected monetary policy (or any other macroeconomic) announcements. Following Gürkaynak, Sack, and Swanson (2007), two types of monetary policy surprises are identified: target and path surprises. The former quantifies to what extent market participants have been able to anticipate the actual outcome of an interest rate decision (based on the change in short-term interest rates surrounding the policy decision) whereas the path surprise gauges the surprise component embedded in the forward-looking guidance (derived from one year ahead implied forward rates).

After deriving target and path surprises, we move on to test hypothesis (i) to (iii). The first hypothesis is assessed based on straightforward descriptive analysis. To this end, we compare the magnitude of target and path surprises across the three economies. The second hypothesis, the anchoring of yield curves, is tested by estimating the effect of monetary policy surprises as well as of a number of key domestic and global (i.e. US and euro area) macroeconomic news on long-term government bond yields across three maturities (five and ten-year spot yields and the five-year forward rates expected to prevail in five-years time). The third hypothesis, to what extent announcement of a policy path enhances the central bank's leverage over longer-term interest rates, is tested by examining whether the medium and long-term yield effect of path surprises is stronger on the days when the central bank publishes its interest rate path forecast or not. This part of the analysis benefits from the fact that all three central banks under investigation pursue the practice of releasing their forward guidance, i.e. their Inflation or Monetary Policy Reports with their forecasts, always on days when also monetary policy decisions are taken.

The main findings of the paper are the following two. First, we find that all three central banks have been highly predictable in their monetary policy

[3]The Norges Bank's operational inflation target is an annual consumer price inflation of 2.5% over time.

decisions and that long-term inflation expectations have been well anchored in the three economies, irrespective of whether forward guidance involved publication of an own interest rate path or not. The first comparative analysis reveals that monetary policy surprises are found to be of similar magnitude for both the RBNZ and the Riksbank, and that there is no evidence that long-term yields are better anchored in New Zealand than in Sweden. The sub-sample analysis for the Norges Bank reveals that policy surprises have become smaller after November 2005, when the Norges Bank started to publish an interest rate path. This latter period was, however, also characterised by very low volatility in the global economy and financial markets in general, which might also have contributed to lower policy surprises. Regarding long-term inflation expectations in Norway, there is no evidence that they have been better anchored after November 2005 than before. These findings suggest that if the central bank already operates under a monetary policy framework characterised by a clearly defined price stability objective and a high degree of transparency, publication of an interest rate path does not appear to enhance the short-predictability of monetary policy and the anchoring of long-term inflation expectations.

The second main finding, obtained from the comparison between RBNZ and the Riksbank, is that the publication of an interest rate path appears to increase the sensitivity of medium term bond yields to forward-looking monetary policy news and reduced sensitivity to news about current policy stance. In New Zealand, five-year bond yields are found to respond weaker to the target surprise and substantially stronger to the forward looking path surprise on the days when the RBNZ publishes its interest rate path. In contrast to this, bond yields in Sweden are not found to have responded differently to monetary policy surprises on the days when the Riksbank published its report with the inflation forecast. This empirical finding suggests that explicit quantitative guidance, in the form of a publication of an interest rate path, may enhance a central bank's leverage on the medium term structure of interest rates.

The remainder of the paper is structured as follows: Section 2 briefly discusses a few conceptual issues of central banks' own interest rate forecasts, namely how they are constructed and presented, what they mean and how they are related to market expectations of future policy rates. Section 3 describes the data and the construction of monetary policy and macro surprises. Section 4 presents the empirical results and Section 5 concludes.

2 Central banks' policy rate forecasts: Conceptual issues

This section briefly discusses a few conceptual issues which might be useful to know prior to delving into the empirical analysis. We start by briefly describing how central banks construct an own interest rate path forecast.

The RBNZ publishes since June 1997 a forecast for the 90-day bill rate as well as for the inflation rate and other key macroeconomic variables together with its Monetary Policy Statement (MPS) four times a year. The primary tool for the construction of the RBNZ's macroeconomic projections is the Forecasting and Policy System (FPS), a large macroeconomic model comprising more than 200 equations. While the published projections are model-based, they also incorporate judgemental adjustments reflecting the views of the staff, the advisory Monetary Policy Committee and ultimately the Governor. After convergence to a baseline projection has been achieved in an iterative process, the MPS with the central projections is eventually released under the authority of the Governor. The interest rate path and the other macroeconomic projections are published without confidence or uncertainty bands.

Since November 2005, the Norges Bank publishes a forecast of its sight deposit rate with confidence bands together with is Monetary Policy Report three times a year. Prior to that, the Norges Bank published an inflation forecast which was constructed based on the assumption of first constant interest rates (from March 2001 until mid 2003) and then market interest rates. The construction of the interest rate path and the forecasts of key economic variables is based on several macroeconomic models, a core model and a number of smaller models. In addition, Norges Bank also takes into account current statistics as well as information provided by regional network and judgemental adjustments. The confidence bands of the interest rate forecast are calculated based on the core model.

The Swedish Riksbank publishes a forecast of its repo rate with confidence bands together with its Monetary Policy Report three times a year since February 2007. Before that, the Riksbank initially used to condition forecasts on the assumption of a constant interest rate (CIR). Since October 2005, the Riksbank gave more prominence to projections based on market interest rate assumptions (MIR) relative to those based on constant interest rate assumptions (CIR) which were included only as an alternative scenario in the Inflation Report.

The Riksbank's forecasts are constructed based on both formal models and expert assessment. On the model side, both models based on economic theory, notably a general equilibrium model of the Swedish economy called RAMSES, and more statistically oriented models are used. The model forecasts are then

examined by the sector experts on the basis of common sense and aspects of reality which the models are unable to capture. The experts' assessment and the results of the models then serve as the basis for the main scenario. The Riksbank publishes the main scenario together with uncertainty bands, which are calculated based on historical forecast errors for implied forward rates with an adjustment for the systematic forecast error in order to capture the existence of risk premia.

Figs. 1a to 1c show how the RBNZ, the Norges Bank and the Riksbank present their interest rate forecasts respectively in their regular reports. The figures reveal that the policy rate is forecasted approximately two years ahead, reflecting the time horizon over which the inflation target is sought or required to be met. While the RBNZ publishes only the point forecast, the Norges Bank and the Riksbank publish the point forecast together with fan charts in order to visualise the uncertainty surrounding the forecast.

As is always stressed in public communication of path-publishing central banks[4], a published interest rate path is not a promise of the central bank. Rather, it is the central bank's best guess, or forecast, at the time of the publication of the forecast of the future path of policy rates, conditional on the information available up to that date. Obviously, unforeseeable future developments will yield ex post a policy rate path possibly looking quite different form the expected paths that have previously been published. This becomes evident when we compare the RBNZ's track record of published interest rate paths with the one that was actually delivered, displayed in Fig. 2. To put the volatility of the RBNZ's policy path forecast into perspective, we show in Fig. 3 the vintage of market expectations of the Riksbank's policy rate (measured by implied forward rates) together with the realised policy rate path. As seen in the figure, market forecasts' are also volatile and not very precise in predicting future policy rates. Yet, this does not imply that markets and central banks are poor forecasters of the future policy rate, it merely shows that they change their mind as the facts change.

In this context, it also important to point out that the central bank 's forecast of the policy rate path and implied market expectations do not need to (and usually don't) accord with each other, since markets and the central bank may have different assessment of the macroeconomic outlook. Indeed, path-publishing central banks commonly acknowledge that aligning market expectations with their forecast is neither to be expected nor desirable.

[4]A typical example is the statement by Riksbank Deputy Governor Rosenberg (2007): "*I would therefore like to emphasise once again that the repo rate path we present in the Monetary Policy Report is a forecast and not a promise. The Riksbank cannot undertake, regardless of what happens in the economy, to follow the path published. The interest rate path is quite simply the best assessment we can make at a given point in time, given the information that is then available. New information may change the picture of the economy and then the Executive Board will have to rethink how we set the repo rate.*", see **?**

However, discrepancies between the central bank 's forecast and market forecasts can at times be picked up as an issue in the financial press. Such a discrepancy was particularly significant when the Riksbank began to publish an interest rate path on 15 February 2007. In the Monetary Policy report, the Riksbank stated that "*The Riksbank's current assessment is that the repo rate needs to be raised by a further 0.25 percentage points in February and by another 0.25 percentage points during the coming six months. There could then be a pause before it is time for a further increase.*" The release of the interest rate path attracted much attention in the media as the path implied a much more accommodative monetary policy than anticipated by the markets. As a result, the market rates shifted down after the Riksbank publication. However, market participants did not revise down the expected repo-rate path fully, leaving a noticeable gap between the implied forward rates and the Riksbank's path over the one to three year horizon, see Fig. 4. The Riksbank's Deputy Governor Irma Rosenberg commented in a speech on the reactions to publishing the Riksbank's own interest rate path in February 2007. The Deputy Governor played down the apparent differences between markets and the Riksbank's view about the future interest rate path "*The fact that other agents make their own assessments of how the interest rate will develop is essentially very positive. One of the arguments put forward against a central bank presenting its own forecast for the interest rate path was that the agents in the financial market would then stop making their own analyses of interest rate developments. However, these misgivings have proved unjustified.*", see Rosenberg (2007).

3 Data issues

3.1 Deriving monetary policy surprises

The earlier literature that has gauged market reactions to the publication of central banks' interest rate path have in general approached this issue by regressing asset price reactions on the surprise component embedded in the published path. The monetary policy surprise component have been derived in different manner. For instance, Archer (2005) defined the expected changes in the Bank's projection as the change in the market yield curve over the period starting three days after the previous projection until 5 minutes before the releases of the new projection. The surprise component was then derived as the difference between the actual change in the projection and the expected change component. Ferrero and Secci (2007) define the monetary policy surprise in the similar manner but use daily data instead of intraday prices. Moessner and Nelson (2008) take yet another road and derives two types of surprises. The first proxy uses the interest rate futures

rate the day prior to the publication of the forecast as the expected component and the second employs the previous central bank forecast made a quarter ago. Although useful, the above mentioned approaches to derive the surprise component cannot distinguish if a monetary policy surprise comes from the fact that the actual monetary policy decision deviated from analysts' expectations and/or if the published path was not in line with market expectations.

To try to capture and disentangle what is driving the overall surprise this paper defines both so-called "target surprises" and "path surprises" for Sweden, Norway and New Zealand. There are in general two approaches how to extract target surprises – survey based or financial markets based measures. There are pros and cons for both. Survey based expectations are usually collected a few days before the monetary policy announcements and, as a result, any news or events taking place between the collection day and the decision day are not reflected in the surveys. Another argument against surveys is that investors do not "put their money where the mouth is". On the other hand, analysts expectations are publicly available, and an analyst would run a reputation risk if his or hers estimate systematically would miss the actual outcome. On the pro side is that survey estimates in theory should reflect investors "true" expectations. This is contrary to expectations derived from financial markets where risk-premiums can drive a wedge between the observed and true expectations. Expectations from financial asset, apart from being derived from real bets by investors, are timely and can be extracted only minutes before the release of the monetary policy decision.

Most studies on asset price reaction surrounding monetary policy news have been conducted on economies where surveys and market based data are easily available for long-time series (United States, euro area and the United Kingdom). However, as concerns the countries examined in this study - Sweden, Norway and New Zealand, data availability is more problematic. In particular, survey based expectations are available only for the past few years. For Sweden and New Zealand (Bloomberg) surveys data start in 2003 and 2001. Similarly, for Norway, survey data are available from 2003 and onwards.

In order to use consistent data for the entire time series, we derive, for all countries, target surprises from financial markets. Daily changes (surrounding the actual decisions) in domestic 1-month interbank rates are used to proxy for the surprise. In more detail, for Sweden the 1-Month Stibor (Stockholm Interbank Offered Rate) rates are employed. Interbank rates normally tend to be good approximations of short-term risk-free rates. The information content can however be distorted during periods of extreme financial stress. For instance the turmoil that got underway in July 2007 sparked a sharp upturn in inter-bank volatility. Our results should not be distorted as this period of financial turbulence is outside of our sample. The STIBOR rates used are the averages of the

interest rates listed at 11:05 a.m. Over the sample under consideration, the monetary policy decision in Sweden have on all occasions been released earlier than 11.00 a.m. (local time). Thus the standardised Riksbank monetary surprise for a monetary policy decision taking place at day t is calculated as:

$$S_t^{MP,\ Sweden} = \frac{i_t^{1M,\ Stibor} - i_{t-1}^{1M,\ Stibor}}{\sigma} \tag{1}$$

where $S_t^{MP,\ Sweden}$, represents the standardised monetary policy surprise for Sweden at day t. $i_t^{1M,\ Stibor}$ is the Stibor rate at day t and σ is the sample standard deviation of the surprise components. For Norway the 1-Month Oibor rates are used. Oibor stands for Oslo Interbank Offer Rate and is set at noon each day. Norges bank has throughout the sample announced their decisions no earlier than 14.00 (local time). Thus the standardised surprise for a monetary policy decision taking place at day t calculated as:

$$S_t^{MP,\ Norway} = \frac{i_{t+1}^{1M,\ Oibor} - i_t^{1M,\ Oibor}}{\sigma} \tag{2}$$

where $S_t^{MP,\ Norway}$ represents the standardised monetary policy surprise for Norway at day t. $i_{t+1}^{1M,\ Oibor}$ is the Oibor rate at day $t+1$and σ is the sample standard deviation of the surprise components.

For New Zealand, 30-days bank bill yields set at noon each day are used. Bank of New Zealand has throughout the sample announced their decisions before noon (local time). Thus the standardised surprise for a monetary policy decision taking place at day t calculated as:

$$S_t^{MP,\ New\ Zealand} = \frac{i_t^{1M,\ Bankbill} - i_{t-1}^{1M,\ Bankbill}}{\sigma} \tag{3}$$

where $S_t^{MP,\ New\ Zealand}$ represents the standardised monetary policy surprise for New Zealand at day t. $i_t^{1M,\ Bankbill}$ is the bank bill rate at day t and σ is the sample standard deviation of the surprise components.

One caveat using bank rates is that they contain credit and liquidity risk components which can distort the information content. However, it is reasonable to assume that these components do not change substantially over very short periods of time and, in general, target surprises derived from market-based measures tend to be very similar to survey-based indicators. For the euro area and the US, the estimated correlation coefficients between the two is 0.75 for the ECB target surprises, and 0.8 for the Fed target surprises, see Andersson (2007). To check the accuracy of the market based data used in this study, Figs. 5 to 7 show scatter plots of target surprises using standard survey based data (when available) and the market based data (as described above).

As seen, the data points are scattered around the 45 degree line and the coefficient of the regression line is very close to one. The strong similarities between the two measures suggest that the market based measure should accurately be able to capture the investors' perceived surprise in the announced decision.

The second type of monetary policy surprises - path surprises - are intended to capture news about revisions in the future path of policy. Methods of how to derive path surprises were first developed by Gürkaynak, Sack, and Swanson (2007)). Later on, Brand, Buncic, and Turunen (2006) and Andersson (2007) have applied slight variations of this method. This study defines the Path Surprise (PS) as the component of the change in around one-year-ahead three-months implied future swap rates surrounding the monetary policy decision that is uncorrelated with the target surprise. In other words, the component of the change in forward swap rates that can not be explained by the target surprise is defined as the PS:

$$\Delta IFR_t^k = \alpha + \beta TS_t^k + PS_t^k \tag{4}$$

where ΔIFR represents the changes in the implied forward rates, TS the target surprises and PS the path surprises.

3.2 Extraction of macroeconomic data surprises

In order to increase the estimation efficiency and minimise omitted variable bias, the surprise components of the most important macro economic releases are controlled for in the regressions. Surprise components are constructed as the difference between the official outcomes and the (median) forecasts obtained from surveys.[5] We included the most important domestic macro variables that were available for a sufficiently long period of time: For New Zealand: CPI inflation, change in retail sales and the unemployment rate. For Norway: CPI inflation, change in retail sales and the unemployment rate. For Sweden: CPI inflation, change in retail sales and the unemployment rate and consumer confidence. In addition, many papers have found that US news tend to move financial prices across the globe, see Andersson, Hansen, and Sebestyén (2006). To control for this market feature, five US macro surprises, including CPI inflation, retail sales, non-farm payrolls, consumer confidence and ISM are added to the domestic regressions. For Sweden and Norway we also include the surprise component of the euro area HICP and the German IFO business climate release, both of which have been found to be important movers of European bond yields.

[5] The data were obtained from Bloomberg and Haver DLX

3.3 Forward rates and benchmark bond yields

The following section evaluates the impact monetary policy surprises have on five and ten-year government bond yields. As mentioned above, the path surprises in eq. (4) are derived as the components of the change in expected future short rates surrounding the monetary policy decision that are uncorrelated with the target surprises. This approach can, however, induce some endogeneity problems in the regression statistics. To see this, the so-called expectation hypothesis states a link between short-term interest rates, and long-term interest rates. This hypothesis is based on the general proposition that expectations about future short-term interest rates affect the current level of long-rates. Thus the n-period long term nominal interest rate at time t, $i_{n,t}$ can be expressed as:

$$i_{n,t} = (1/n)[E_t(i_{1,t}) + E_t(i_{1,t+1}) + E_t(i_{1,t+2}) + \ldots + E_t(i_{1,t+n-1})] + \theta_{n,t} \qquad (5)$$

where $E_t(i_{1,t+i})$ is the one-period yield which markets at time t expect to prevail at time $t + i$. $\theta_{n,t}$ is the term premium paid on an instrument with maturity n. Thus, as short-term interest rates are controlled by the central bank, monetary policy (in particular policy surprises) also has an impact on long-term interest rates. Applied on ten-year bond yields, the endogeneity problems should however be deemed as relatively small as it is derived from one small component in eq.(5), namely the $E_t(i_{1,t})$ component. To account for this feature we add the five-year forward interest rate expected to prevail in five years time to the explanatory variables. These forward rates have the additional advantage that they, at least in theory, should be unaffected by short-term business cycle news. As a consequence, central banks usually monitor these forward rates to gauge changes in market participants long-term growth and inflation prospects.

The five and ten-year (and the forward) benchmark bond yields are derived from Datastream, using the codes BMXX10Y and BMXX05Y, where XX represents the two digit country codes for New Zealand, Norway and Sweden.

4 Empirical Analysis

As mentioned in the introduction, the main aim of this paper is to evaluate effects of quantitative forward guidance provided by the RBNZ, the Riksbank and Norges Bank. Three avenues are pursued; the first concerns the predictability of monetary policy decisions, the second if quantitative forward guidance has helped to anchor long-term inflation expectations and, the third, if a move towards an interest rate path publication increases a central bank's leverage on the term-structure of interest rates. We use descriptive statistics to evaluate the predictability issue whereas regression analysis will be employed to tackle the two

latter points. Throughout the Section we will employ identical samples for RBNZ and the Riksbank (covering the period January 1999 to January 2007). This enables us to compare two central banks that share similar policy frameworks, but differ in the sense that the RBNZ's is more explicit in its forward communication (via the publication of an own interest rate path). For Norway, the sample is split before and after their decision to publish an own interest rate path (in November 2005). Such a sample split helps to gauge to what extent markets' reaction to Norges bank's communication have changed after they decided to publish their best guess about future policy rates.

(i) Does publication of an interest rate path enhance the short-term predictability of monetary policy and help to avoid policy surprises?

Predictability is of essence for a central bank because it enhances the effectiveness of monetary policy. In this respect it is common to distinguish between short-term predictability and long-term predictability. Short-term predictability is usually defined as the degree at which the public is able to anticipate the upcoming monetary policy decisions. The longer term dimension of central bank predictability has more to do with the fact that the public should be able to understand the central bank's monetary policy framework (see ECB (2006) and Blattner, Catenaro, Ehrmann, Strauch, and Turunen (2008) for a more thorough discussion).

In this sub-section we focus on short-term predictability and make use of the above-derived target and path surprises. Fig. 8 shows the unconditional mean of both target and path surprises for the three economies. As evident by the rather low level of target and path surprises, all three central banks have been successful in communicating their monetary policy intentions in a transparent manner. Furthermore, the target surprises are of similar magnitude for both RBNZ and the Riksbank while RBNZ's path surprises, on average, have been slightly higher than for the Riksbank. This latter feature suggests that the RBNZ's decision to publish its own interest rate path has not had any significant short-term predictability benefits, at least in comparison to the Riksbank.

For Norges Bank, it seems that its short-term predictability has improved after the introduction of the interest rate path. In fact, both target and path surprises have declined significantly after November 2005. It should, however, be noted that the 2005 to mid-2007 period was characterised by tranquil financial market environment. Such a favourable environment probably made it easier for market participants to anticipate upcoming monetary policy decisions.

(ii) Does the introduction of an interest rate path help to anchor long-term inflation expectations?

To examine to what extent the three central banks have been able to anchor long-term inflation expectations we use a standard regression framework. The Fisher hypothesis states that the yields offered on government bonds essentially

are made up by three components, a real rate component, an inflation expectation component and a premium demanded to invest in longer term securities. The real rate component is, in turn, closely related to an economy's economic growth prospects. By assuming that market participants' economic growth five to ten years into the future as well as the term premia they demand over this horison are broadly constant, changes in far-ahead forward rates should primarily be related to revisions in long-term inflation expectations, as seen through the eyes of investors (see Gürkaynak, Sack, and Swanson (2005)). Thus, if monetary policy (and other macroeconomic) surprises are unable to significantly move the yields on this long-term horizon, this would provide evidence that market participants' long-term inflation expectations are well anchored.[6]

To test this hypothesis we employ a standard exponential GARCH (EGARCH) model proposed by Nelson (1991). This set-up is similar to previous studies investigating the effect of monetary policy surprises and communication on market interest rates (Ehrmann and Fratzscher (2007)).

We explore both mean and volatility effects of monetary policy surprises and macro news surprises on five-year forward rates.[7] For completeness we also replicate this regression for five and ten year government spot rates. The benchmark case estimates the following mean equation:

$$\Delta r_t = \alpha + \beta r_{t-1} + \gamma_1 TS_t + \gamma_2 PS_t + \Phi X_t + \epsilon_t \tag{6}$$

where Δr represents daily changes in forward rates/benchmark bond yields, TS is the monetary policy target surprise, PS is the monetary policy path surprise and X is a matrix containing domestic, US and euro area macro economic news.

The conditional variance equation is given by:

$$\ln(\sigma_t^2) = \omega + \phi_1 \left(\left| \frac{\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} \right| - \sqrt{\frac{2}{\pi}} \right) + \phi_2 \left(\frac{\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} \right) + \phi_3 \ln(\sigma_{t-1}^2) + \Phi_4 DM_t + \Phi_5 DX_t \tag{7}$$

where DM is a dummy variable equal to one on days of monetary policy decisions and zero otherwise and DX is a vector of dummies for the domestic, US and euro area macro news (taking respectively the value one on days the news

[6] A more direct approach would be to assess the anchoring of implied long-term inflation compensation backed out from the forward rates of nominal and index-linked bonds, as has been done by Beechey and Wright (2008) for the US. We did not pursue this avenue here because of an insufficient number of on-the-run index linked bonds for the three economies.

[7] An alternative approach would be to gauge the impact on shorter forward rates such as one-year implied forward rates in nine years time. As benchmark yields (with high liquidity) are available in the five year and ten year segments, we believe the information content in longer-term implied forward rates (i.e. five year forward rate five years ahead) to be less distorted than shorter-term implied forward rates (e.g. one year forward rate nine years ahead).

are revealed and zero otherwise). Table 1 reports the results. Two main results emerge from the Table. First, target and path surprises, across economies (and across samples in the case of Norway), have lower coefficient values and fewer significance for the implied five-year forward interest rates compared to the five and ten-year spot yields. This suggests that long-term inflation expectations have been relatively well anchored in the three economies over the sample periods.

Second, this pattern also holds for the vast majority of domestic and foreign macroeconomic news. An important market mover appears to be the surprise in US non-farm payroll releases, which is found to significantly move bond yields for all three economies, across maturities, except for Norway over the more recent sample period. The fact that relatively few monetary policy surprises and macro news exert significant influence on long-term forward rates contrasts findings for the United States found by Gürkaynak, Sack, and Swanson (2005). The authors state that "*our empirical results are all consistent with a model that we present in which private agents' views of [US] long-run inflation are not strongly anchored*". One plausible explanation for the contrasting results may be that all three economies included in this study have a clear inflation mandate which differs from the Federal Reserve's informal approach to a long-run inflation objective. This explanation is also supported by Gürkaynak, Levin, and Swanson (2006) who find evidence that Swedish and UK long-term inflation compensation embedded in bond yields have been insensitive to economic news during the period when the economies have operated under a clear inflation mandate. Similarly, applied to the pricing of New Zealand's yield curve, Drew and Karagedikli (2008) gauge the interest rate sensitivity to RBNZ monetary policy surprises. They find that the estimated impact diminishes at longer horizons and attribute this to the fact that market participants "*expect that the RBNZ will get on top of inflationary pressure over the longer run*".

(iii) Does quantitative guidance in the form of interest rate path publication improve central banks' leverage over the term structure of interest rates?

When an interest rate path is released, financial markets are provided with detailed quantitative information about the prospective future course of policy. One might therefore conjecture that on these days, markets may be more reactive to the forward looking communication, which would imply that bond yields respond stronger to the path surprise. From a tactical central bank communication perspective, this would open a way to exert a larger influence (i.e. leverage) on longer-term bond yields. For instance, assume that a central bank wishes to steer bond yields in a certain direction and that history has shown that they are able to "move the markets" more when they publish a path. If that were the case, then the central bank would be more successful to steer markets by direct forward guidance rather than by means of a speech or some other form of verbal guidance.

Owing to the limited number of interest rate paths published by Norges Bank between November 2005 and June 2007, the assessment of this conjecture is based solely on a comparative analysis of New Zealand and Sweden. To this end, we extend the EGARCH model estimated in the previous sub-section by interacting the monetary policy surprises with a dummy variable (D_t^{fguid}) which is equal to one on days when an interest rate path in the case of New Zealand and the inflation forecast in the case of the Riksbank was released and zero on the occasions when the two central banks only published the interest rate decision.

$$\Delta r_t = \alpha + \beta r_{t-1} + \gamma_1 TS_t + \gamma_2^P TS_t D_t^{fguid} + \gamma_3 PS_t + \gamma_4 PS_t D_t^{fguid} + \Phi X_t + \epsilon_t \quad (8)$$

If quantitative forward-looking guidance induces increased central bank leverage on the term structure of interest rates, we would expect the coefficient on the dummy-interacted path surprise to be positive and significant. The expected size and sign of the coefficient of the dummy-interacted target surprise is not clear a priori.

Table 2 reports the estimated coefficients for the monetary policy surprises. For New Zealand we find that the effect of the path surprise is consistently larger when an interest rate path was published (see Panel A). However, it is only significant for the five year segment. The effect of the target surprise, on the other hand, is found to be smaller, which could be interpreted as reflecting a shift in the bond markets' focus from the very near term monetary policy stance (as captured by the target surprise) to the more distant monetary policy outlook (as captured by the path surprise). The coefficient estimates suggest that the RBNZ can considerably enhance its leverage over medium term bond yields when it publishes a policy rate path, since the elasticity of the five year bond yield to the path surprise is almost twice as large on these days than normally. For Sweden, interest rates are not showing any extra sensitivity on the days they publish their monetary policy report (see Panel B). Overall, these findings lend support for the notion that publication of an interest rate path forecast enhances the central banks leverage over medium-term interest rates.

5 Conclusions

The perceived primary advantage of publishing an own interest rate path is that it would enhance the central banks ability to steer expectations, thereby enhancing the predictability of monetary policy, the anchoring of inflation expectations and the leverage of monetary policy over longer term interest rates. The purpose of this paper assesses these hypotheses in the following ways. First, we test if a publication of an own interest rate path can enhance the predictability of

monetary policy, i.e. help avoiding policy surprises and thereby reduce financial market volatility. This is evaluated by examining the size of the three central banks' target and path surprises. Second, by examining the price sensitivity of long-term domestic government bond yields (both spot and forwards) on derived path and target surprises, we are able to evaluate if a publication of an interest rate path has altered investors' long-term inflation expectations. Third, one of the main arguments in favour of publishing an interest rate path is that it may improve the banks' leverage over the term structure of interest rates. We test this issue empirically by examining whether the medium and long-term yield effect of path surprises is stronger on the days when the central bank publishes its interest rate path forecast or not. This part of the analysis benefits from the fact that all three central banks under investigation pursue the practice of releasing their forward guidance, i.e. their Inflation or Monetary Policy Reports with their forecasts, always on days when also monetary policy decisions are taken.

The analysis is based on two comparisons. First, a comparative analysis for the RBNZ and the Riksbank over a sample period were the RBNZ, but not the Riksbank published an own interest rate forecast. Second, we also perform a comparative analysis for the Norges Bank over two different sub-samples, when interest rate forecast was published in the second sub-sample, but not in the first.

The main findings of the paper are the following two. First, we find that all three central banks have been highly predictable in their monetary policy decisions and that long-term inflation expectations have been well anchored in the three economies, irrespective of whether forward guidance involved publication of an own interest rate path or not. The first comparative analysis reveals that monetary policy surprises are found to be of similar magnitude for both the RBNZ and the Riksbank, and that there is no evidence that long-term yields are better anchored in New Zealand than in Sweden. The sub-sample analysis for the Norges Bank reveals that policy surprises have become smaller after November 2005, when the Norges Bank started to publish an interest rate path. This latter period was, however, also characterised by very low volatility in the global economy and financial markets in general, which might also have contributed to lower policy surprises. Regarding long-term inflation expectations in Norway, there is no evidence that they have been better anchored after November 2005 than before. These findings suggest that if the central bank already operates under a monetary policy framework characterised by a clearly defined price stability objective and a high degree of transparency, publication of an interest rate path does not appear to enhance the short-predictability of monetary policy and the anchoring of long-term inflation expectations.

The second main finding, obtained from the comparison between RBNZ and the Riksbank, is that the publication of an interest rate path appears to increase the sensitivity of medium term bond yields to forward-looking monetary policy

news and to reduce sensitivity to news about current policy stance. In New Zealand, five-year bond yields are found to respond weaker to the target surprise and substantially stronger to the forward looking path surprise on the days when the RBNZ publishes its interest rate path. In contrast to this, bond yields in Sweden are not found to have responded differently to monetary policy surprises on the days when the Riksbank published its report with the inflation forecast. This empirical finding suggests that explicit quantitative guidance, in the form of a publication of an interest rate path, may enhance a central bank's leverage on the medium term structure of interest rates.

For completeness, it is important to note that there are other aspects of publishing an own interest rate path on top of the predictability, anchoring of inflation expectations and leverage issues which have been the focus in this paper. There are, for instance, further potential advantages such as avoiding a number of technical problems associated with the adoption of the market interest rate (MIR) approach in the construction of central banks' macroeconomic forecasts [8]and the establishment of a more forward looking framework of the internal policy deliberations. At the same time, there are also potential disadvantages. In particular, it might in practice be difficult for a monetary policy committee to agree on an entire future path of policy rates rather than merely on the level of the policy rate today (Goodhart (2001)), an argument whose relevance obviously grows with the size of the decision making body. The relevance of these further potential advantages and disadvantages will depend to a large extent on the specific situation at the individual central bank, such as the importance of the inflation forecast in the monetary policy strategy and the size of the decision making body.

[8]These potential problems are: (i) Difficulties in extracting measures of expected future repo rates from implied forward rates due to possible distortions related to the existence of various premia which are potentially time varying; (ii) risks of the perceptions that the central bank may be steered by financial markets when the inflation forecast is based on market interest rate expectations; and (iii) difficulties in communication when the central bank has a different view from the markets as to what constitutes a reasonable path for the future policy rate

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Table 1 Baseline results for New Zealand, Sweden and Norway

Panel A: New Zeeland

	Five		Ten		Five year Forward	
	Mean	Volatility	Mean	Volatility	Mean	Volatility
lag	-0.01		-0.02		-0.03 *	
Target Surprise	3.43 ***		2.22 ***		0.94	
Path Surprise	4.42 ***	-0.43 ***	3.56 ***	-0.31 ***	2.57 ***	-0.29 ***
NZ cpi	2.43 **	-0.02	1.78 ***	-0.01	1.49	0.02
NZ rsa	1.17 **	0.11 *	0.79	0.10 **	0.50	0.05
NZ unempl	-9.68 ***	-0.12	-7.68 ***	-0.17 *	-3.45	-0.02
US cpi	0.33	-0.14	0.40	-0.09	0.51	-0.14 *
US rsa	0.85	0.12 *	0.68	0.16 **	0.39	0.11 *
US nfp	2.01 ***	0.01	2.42 ***	0.09	2.63 ***	0.01
US ISM	1.55 ***	0.08	1.86 ***	0.14 *	1.79 ***	0.08

Panel B: Sweden

	Five		Ten		Five year Forward	
	Mean	Volatility	Mean	Volatility	Mean	Volatility
lag	0.04 **		0.03 **		0.03	
Target Surprise	1.73 ***		1.08 *		0.53	
Path Surprise	2.16 ***	0.07	1.84 ***	0.12 **	1.41 **	0.12 **
SW cpi	2.31 ***	0.06	1.20 ***	0.17 *	0.25	0.12 **
SE rsa	0.59	0.04	0.29	0.05	0.02	0.22 ***
SW unempl	-0.82 **	0.03	-0.64 *	-0.10	-0.58	-0.25 ***
US cpi	0.37 **	-0.05	0.29	0.01	0.25	0.14 **
US rsa	2.12 ***	0.01	1.79 ***	0.01	1.50 ***	0.09 *
US nfp	2.67 ***	0.01	2.41 ***	-0.04	2.02 ***	-0.40 ***
US ISM	2.97 ***	0.47 ***	1.71 ***	0.49 ***	0.38	0.95 ***
EA cpi	0.83 **	-0.07	0.63	-0.18	0.72 **	-0.55 ***
EA ifo	0.81 **	-0.14 **	0.70 ***	-0.16 **	0.54	-0.16 ***

Panel C1: Norway 2001 - 2005

	Five		Ten		Five year Forward	
	Mean	Volatility	Mean	Volatility	Mean	Volatility
lag	0.06 **		0.09 ***		-0.08 ***	
Target Surprise	3.73 ***		2.00 ***		0.36	
Path Surprise	5.74 ***	0.28 ***	2.47 ***	-0.16	-1.35	-0.38 ***
NO cpi	3.78 ***	0.04	1.84 ***	-0.06	-0.10	-0.14 ***
NO rsa	0.46	0.31 ***	0.32	0.41 ***	0.39	0.17 ***
NO unempl	-1.42	0.22 ***	-0.03	-0.02	1.40 *	-0.16 ***
US cpi	0.52	-0.05	-0.62	-0.12	-0.84	-0.19 ***
US rsa	1.56 *	0.08 *	1.55 **	0.27 *	1.93 ***	0.03 ***
US nfp	1.90 ***	-0.47 ***	3.26 ***	0.02	4.42 ***	-0.24 ***
US ISM	1.82 ***	0.62 ***	1.47 ***	0.41 **	0.51	0.51 ***
EA cpi	-0.14	0.52 ***	-0.69	0.07	-0.69	0.15 ***
EA ifo	1.43 ***	-0.35 ***	0.92 **	-0.35 ***	0.76 **	-0.20 ***

Panel C2: Norway 2005 - 2007

	Five		Ten		Five year Forward	
	Mean	Volatility	Mean	Volatility	Mean	Volatility
lag	0.04 *		0.02		-0.20 ***	
Target Surprise	4.19 ***		1.62		-0.36	
Path Surprise	2.24 *	0.12 ***	1.54 *	0.20 ***	1.89	0.60 ***
NO cpi	2.26 ***	0.52 ***	1.75 ***	0.23 ***	1.19	0.32 ***
NO rsa	1.03	0.02 ***	-0.99 *	-0.01	-2.30 **	-0.07 ***
NO unempl	-1.29 ***	-0.11 ***	-1.94 ***	-0.19 ***	-2.68 ***	0.03
US cpi	-0.15	0.16 ***	0.06	-0.09 ***	0.53	-0.09 ***
US rsa	1.30	0.16 ***	0.95	0.15 ***	0.63	0.43 ***
US nfp	1.62 ***	0.00	0.77 **	0.14 ***	-0.41	-0.23 ***
US ISM	-0.14	0.06 ***	-0.83	0.06 ***	-1.45	0.46 ***
EA cpi	-0.67	-0.02	0.77	-0.33 ***	1.14	-0.28 ***
EA ifo	0.41	-0.46 ***	0.54	-0.04 ***	0.45	0.24 ***

*,**,**, denotes significance at the 10%, 5% and 1% level.

Table 2 Extended regression results for News Zealand and Sweden

Panel A: New Zeeland

	Five Mean	Ten Mean	Five year Forward Mean
Target Surprise	3.74 ***	2.99 ***	2.15 ***
Path Surprise	2.96 ***	2.45 ***	1.77 ***
Target Surprise DP	-0.65 ***	-1.85 ***	-2.98 ***
Path Surprise DP	2.27 **	1.63	1.17
Exclusion test	7.51 ***	5.14	2.65

Panel B: Sweden

	Five Mean	Ten Mean	Five year Forward Mean
Target Surprise	1.71 ***	0.88 ***	0.08
Path Surprise	2.35 ***	1.79 ***	1.29 *
Target Surprise DR	0.12	0.33	0.56
Path Surprise DR	-0.47	0.01	0.10
Exclusion test	0.33	0.06	0.43

*,**,**, denotes significance at the 10%, 5% and 1% level. 'Exclusion test' reports the significance level of a Likelihood ratio test of the null hypothesis that all dummy-interacted monetary policy variables in the mean and the volatility equation can be excluded from the model.

Fig 1: Key policy rate and interest rate path for New Zealand, Norway and Sweden

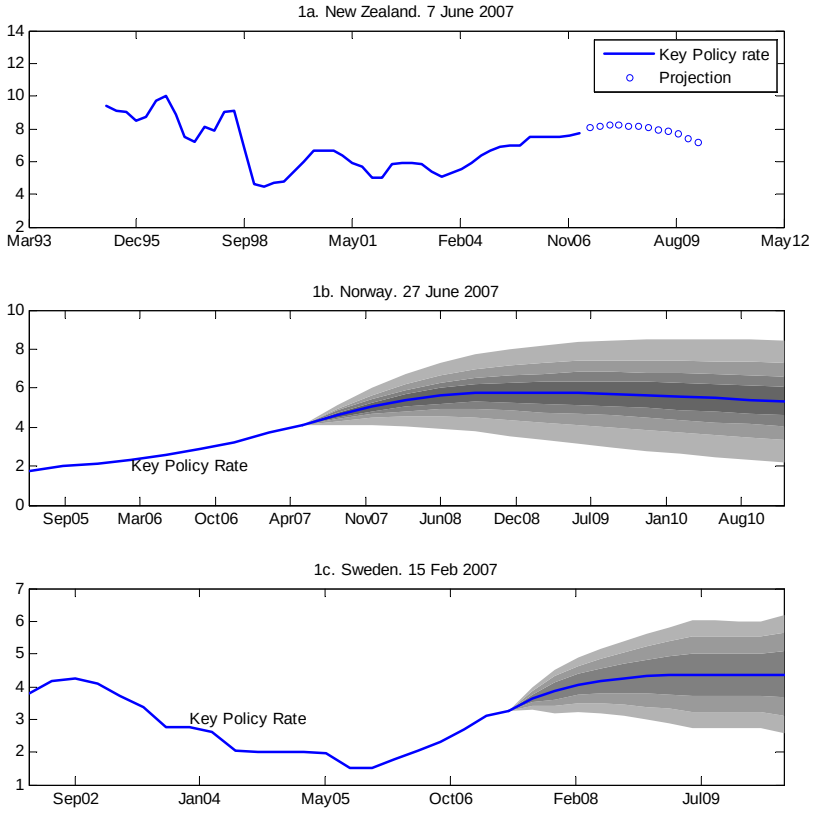

Fig 2: Track record for RBNZ

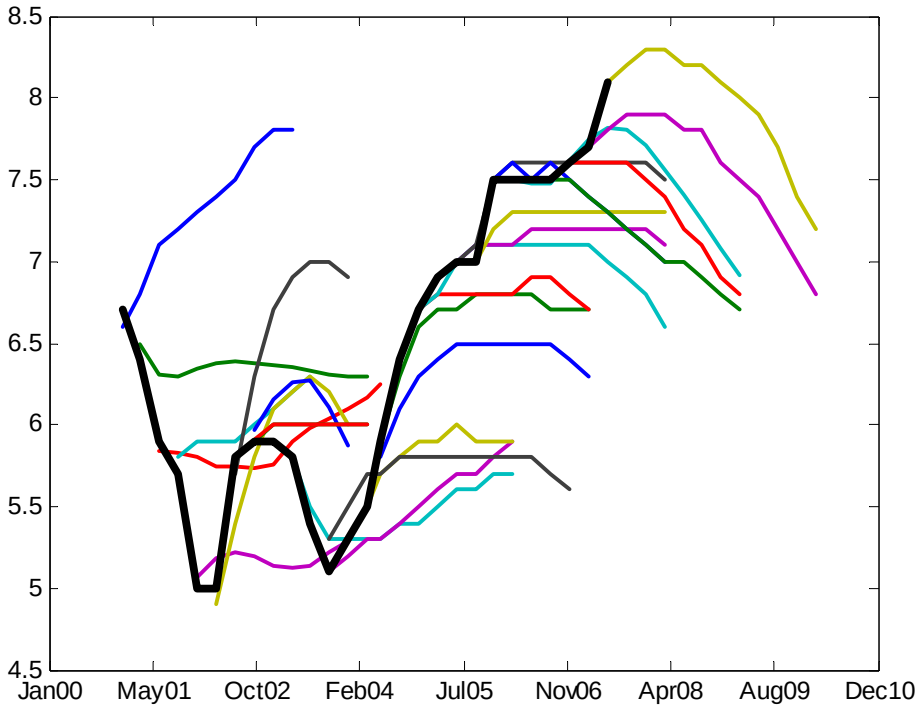

Fig 3: Track record for Sveriges Riksbank *(January 1999 – January 2007)*

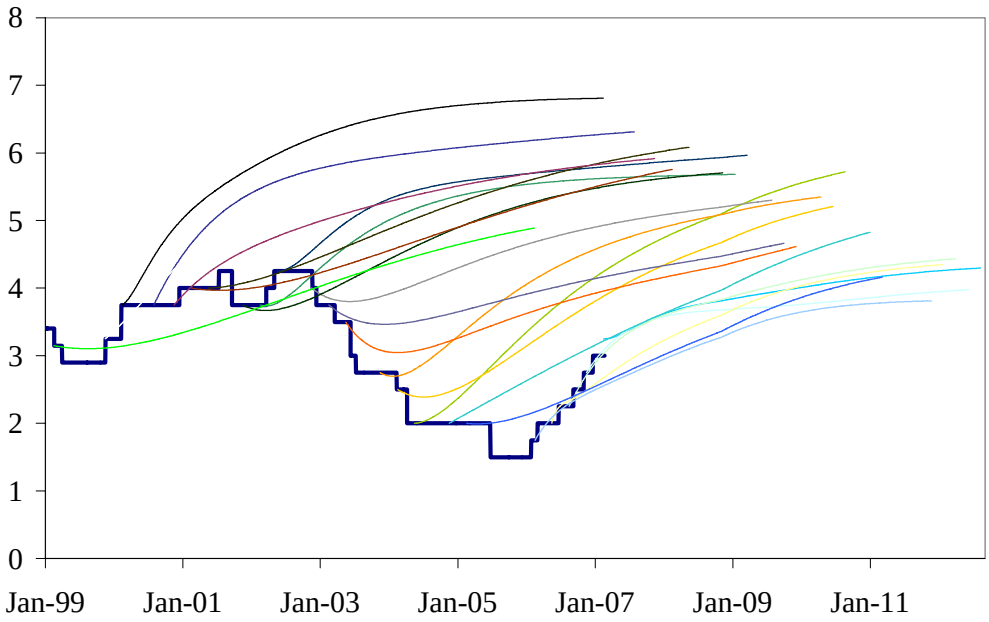

Fig 4: Riksbank repo rate forecast and market expectations in February 2007 (in % p.a.)

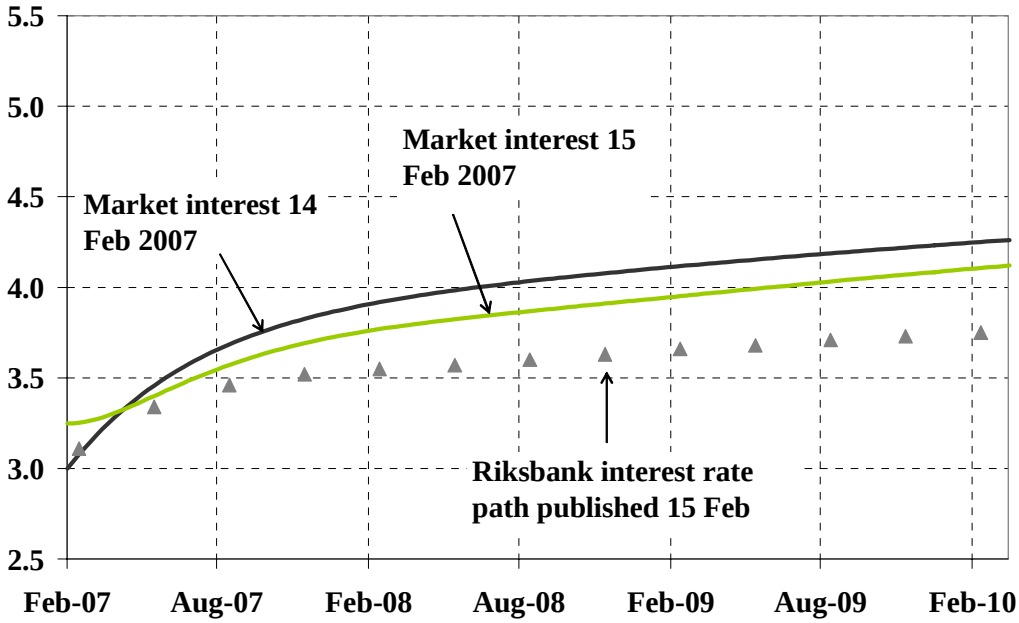

Fig 5: Survey based *(y-axis)* and market based *(x-axis)* measures of monetary policy target surprises for New Zealand
(in basis points, April 2001 – June 2007)

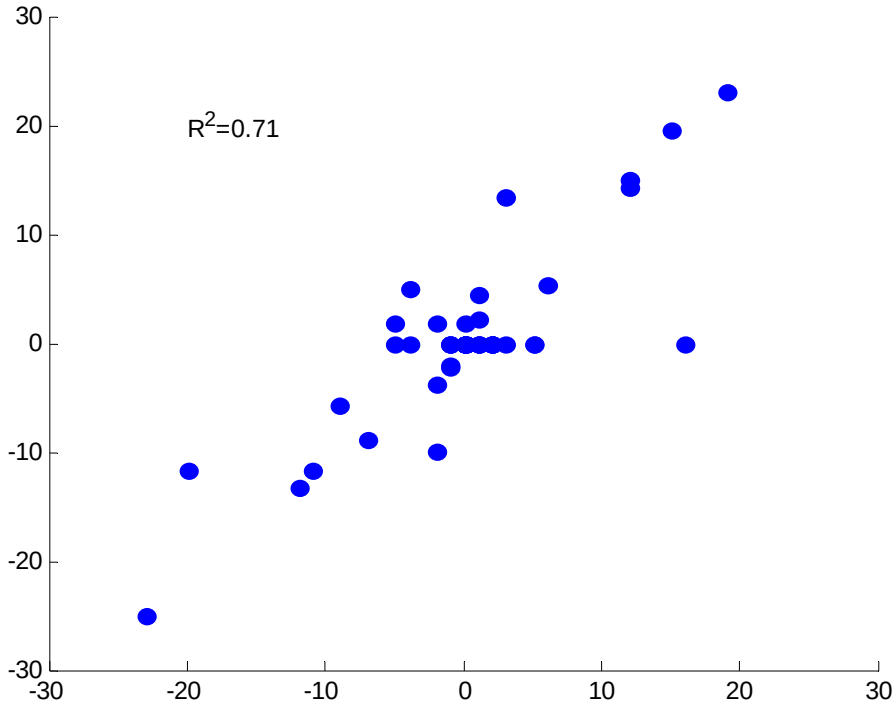

Fig 6: Survey based *(y-axis)* and market based *(x-axis)* measures of monetary policy target surprises for Norway
(in basis points, June 2003 – June 2007)

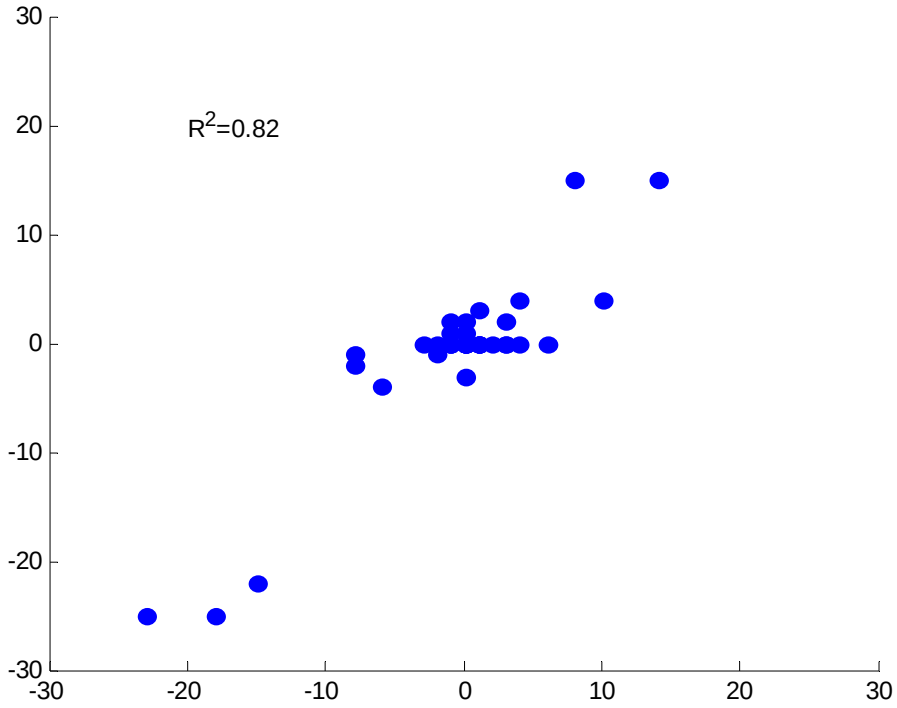

Fig 7: Survey based *(y-axis)* and market based *(x-axis)* measures of monetary policy target surprises for Sweden
(in basis points, October 1999 – June 2007)

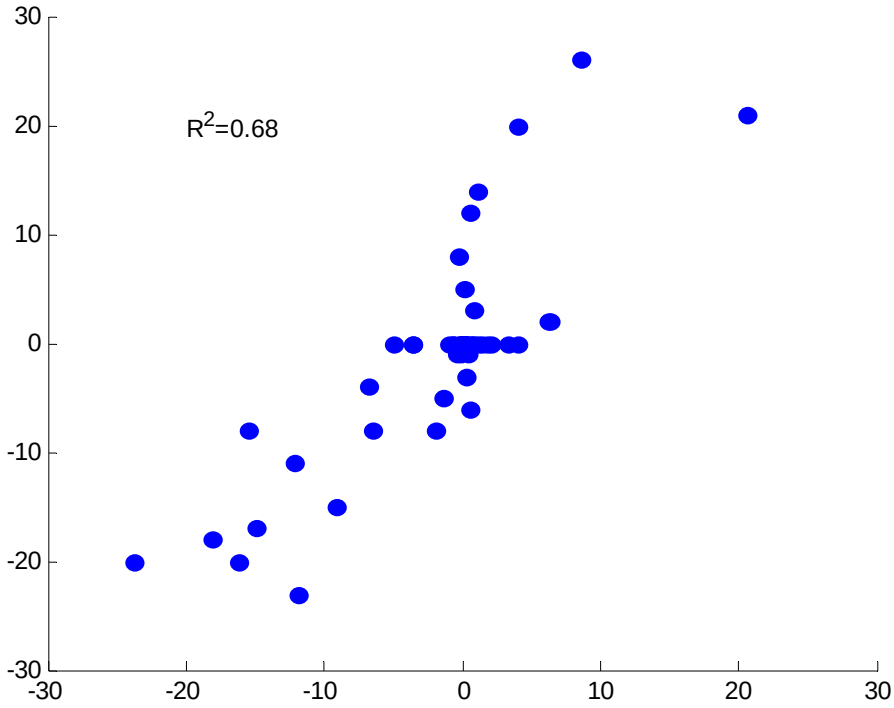

Fig 8: Average absolute target and path surprises for the Reserve Bank of New Zealand, the Riksbank and Norges Bank
(Sample period: for New Zealand and Sweden: January 1999 – January 2007, Norway 1: March 2001 - October 2005, Norway 2: November 2005 - June 2007)