EUROPEAN CENTRAL BANK

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GAUGING THE EFFECTIVENESS OF QUANTITATIVE FORWARD GUIDANCE

EVIDENCE FROM THREE INFLATION TARGETERS

by Magnus Andersson
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In 2009 all ECB publications feature a motif taken from the €200 banknote.

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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 weak evidence that a publication of a path could potentially enhance a central bank's leverage on the medium term structure of interest rates.

Keywords: Monetary policy, transparency, central bank communication, forward guidance, term structure of interest rates

JEL Classification: E40, E43, E52

Non-Technical Summary

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. In order to assess this hypothesis, we perform two types of comparative analyses focusing on the incidence of monetary policy surprises and their effects on longer term bond yields. First, a comparative analysis is conducted for the Reserve Bank of New Zealand (RBNZ) and the Swedish Riksbank over a sample period where the RBNZ but not the Riksbank published an own interest path, while otherwise both central banks operated under fairly similar conditions and policy frameworks. Second, we perform a comparative analysis for the Norges Bank over two different sub-samples periods, where an interest rate path was published in the second sub-sample but not in the first.

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 weak evidence that a publication of a path may potentially enhance a central bank's leverage on the medium term structure of interest rates.

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 communication of the prospective future course of monetary policy. The standard practice amongst central banks is to provide forward guidance via a projection or forecast of their goal variables (mainly inflation and real economic growth) and other standard channels, such as press conferences, statements and speeches. A few inflation-targeting central banks have gone one step further and give quantitative forward guidance by publishing their own projection or forecast of the future path of policy rates. This practice is currently pursued by four inflation targeters, the Reserve Bank of New Zealand (since 1997), Norges Bank (since 2005)[1], the Swedish Riksbank (since 2007), and the Czech National Bank (since 2008). The vast majority of central banks, in particular the leading non-inflation targeting central banks, the Federal Reserve, the ECB and the Bank of Japan, but also the Bank of England as one of the leading inflation targeting central banks,[2] have so far decided against publishing an own interest rate path.

From a theoretical point of view, the main argument brought up in favour of publishing an own interest rate path by the central bank is that it would enhance the central bank's ability to manage expectations and thereby facilitate the transmission of monetary policy (Woodford 2005, Svensson 2006 and 2008, Rudebusch and Williams 2008). This is also the primary perceived advantage of publishing an own interest rate path from the perspective of central banks that have adopted this tool (Rosenberg 2007, Gjedrem 2006). More specifically, it is held that 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) by 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 to avoid 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; and

(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 lower 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 shape market expectations of the future path of policy rates.

The bulk of the empirical literature on the effects of central bank transparency and communication on monetary policy effectiveness is focused on the world's leading central banks and only a very few studies address the implications of the publication of the central bank's own interest rate path.[3] For reasons of sample length, these studies exclusively focus on the Reserve Bank of New Zealand (RBNZ) and Norges Bank.[4] Some of these studies have also touched upon the issues examined in this paper, namely quantitative forward guidance and the effect on (i) predictability, (ii) anchoring of long-term inflation expectations and (iii) potential leverage on the term structure of interest rates. Regarding the effects of quantitative forward guidance on predictability, there is some evidence suggesting that publication of an interest rate path reduces the volatility of short-term interest rates, implying that it may have enhanced predictability (Holmsen et al. 2008 and Ferrero and Secchi 2007).[5] Concerning the anchoring of inflation expectations, there is only one study on New Zealand (Drew and Karagedikli 2008) which finds that the impact of monetary policy surprises diminishes at longer horizons, which is interpreted as implying that inflation expectations are well anchored. However, it remains open what role the publication of an interest rates path plays in this result.[6] A number of studies have explored the

implications of the RBNZ's quantitative forward guidance on monetary policy leverage over short- to medium-term market interest rates (Archer 2005, Ferrero and Secchi 2007, Moessner and Nelson 2008). The results suggest that RBNZ's policy path surprises do have a positive but weak effect on market interest rates. This evidence is, however, not informative with regard to the question if a release of an interest rate path enhances a central bank's leverage over market interest rates, as such an assessment would require a comparison with other central banks that do not publish such a path.

This brief review of the existing empirical literature reveals that the incremental impact of publishing an own interest rate path on the three different aspects of policy effectiveness highlighted above has so far not been addressed in a consistent manner. The contribution of this paper is to fill this gap by developing a comparative approach for testing all three of the above stated hypotheses, based on a consistent analytical framework. The main challenge in this regard 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 centred on steering the overnight cash rate) to 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[7] and a high degree of transparency,[8] and

their forecasts are released (via their regular publications) on days when monetary policy decisions are also taken. The latter is important for our analysis of hypothesis (iii) as we explain in more detail below. The lack of coincidence of the forecast release and monetary policy decisions is also the reason why other leading inflation targeting central banks, most notably the Bank of England, are excluded from the analysis.

Second, we also perform a comparative analysis for Norges Bank over two different periods, covering the periods March 2001 to October 2005 and November 2005 to June 2007. The start and end points of the two samples are determined by Norges Bank's switch from exchange rate to inflation targeting in March 2001,[9] 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. Since 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 et al. (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 hypotheses (i) to (iii). The first hypothesis is assessed on the basis of 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 pieces of 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, on days when monetary policy decisions are also taken.

The main findings of the paper are the following. 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 Norges Bank reveals that policy surprises have become smaller after November 2005, when 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-term predictability of monetary policy or the anchoring of long-term inflation expectations.

The second main finding, obtained from the comparison between the 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 the sensitivity of bond yields to news about the current policy stance. In New Zealand, five-year bond yields are found to respond more weakly to the target surprise and substantially more strongly 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 the publication of an interest rate path, may potentially 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 it is useful to clarify before embarking on the empirical analysis. We start by briefly describing how central banks construct an own interest rate path forecast.

Since June 1997, the RBNZ has published 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, Norges Bank has published a forecast of its sight deposit rate with confidence bands together with its Monetary Policy Report, three times a year. Prior to that, Norges Bank published an inflation forecast which was constructed on the basis of the assumption of first constant interest rates (from March 2001 until mid 2003) and then market interest rates. Before publishing an explicit forecast of the policy rate path up to three years ahead, Norges Bank published from summer 2004 a 'strategy interval' for the policy rate four months ahead. The construction of the interest rate path and the forecasts of key economic variables are 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 its regional network and judgemental adjustments. The confidence bands of the interest rate forecast are calculated on the basis of the core model.

The Swedish Riksbank has published 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). From 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 on the basis of 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 from historical forecast

errors for implied forward rates with an adjustment for the systematic forecast error in order to capture the existence of risk premia.

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

[Figures 1a-c near here]

As is always stressed in the public communications of path-publishing central banks,[10] a published interest rate path is not a promise by 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 which may look 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 Figure 2. To put the volatility of the RBNZ's policy path forecast into perspective, we show in Figure 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.[11]

[Figures 2, 3 near here]

In this context, it is 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 do not) accord with each other, since markets and the central bank may have different assessments of the macroeconomic outlook. Indeed, path-publishing central banks commonly acknowledge that the alignment of market expectations with their forecast is neither to be expected nor desirable.

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 that anticipated by the markets. As a result, market rates shifted down after the report's 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 Figure 4. The Riksbank's Deputy Governor, Irma Rosenberg, commented in a speech on the reactions to the publication of the Riksbank's own interest rate path in February 2007. The Deputy Governor played down the apparent differences between the 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.' (Rosenberg, 2007).

[Figure 4 near here]

3 Data and surprises

Deriving monetary policy surprises

The earlier literature which has gauged market reactions to the publication of central banks' interest rate paths has in general approached this issue by regressing asset price reactions on the surprise component embedded in the published path. The monetary policy surprise components have been derived in different ways. For instance, Archer (2005) defined the expected changes in the central 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 release 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 Secchi (2007) defined the monetary policy surprise in a similar manner but used daily data instead of intraday prices. Moessner and Nelson (2008) took yet another approach and derived two types of surprises. Their first proxy used the interest rate futures rate on the day prior to the publication of the forecast as the expected component and the second employed the previous central bank forecast made a quarter ago. Although useful, these approaches to deriving the surprise component cannot distinguish whether a monetary policy surprise results from the actual monetary policy decision deviating from analysts' expectations or from the published path not being 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 to extracting target surprises – survey based or financial market 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 her estimate systematically missed the actual outcome. An argument in favour of surveys is that survey estimates should in theory reflect investors 'true' expectations. This is contrary to expectations derived from financial markets where risk-premia can drive a wedge between the observed and true

expectations. On the other hand, expectations from financial asset prices, 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 reactions to monetary policy news have been conducted on economies where monetary policy expectations are easily available for long time periods (the United States, the 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 (Bloomberg survey data are available for New Zealand from 2001 and for Sweden and Norway from 2003).

In order to use consistent data for the entire time series, we derive target surprises from financial markets for all countries. Daily changes (surrounding the actual decisions) in domestic 1-month interbank rates are used to proxy for the surprise. In more detail, we employ the 1-Month Stibor (Stockholm Interbank Offered Rate) rates listed at 11:05 a.m. for Sweden, the 1-Month Oslo Interbank Offer Rate (Oibor) set at noon each day for Norway and the 30-day bank bill yield also set at noon for New Zealand. 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 interbank rate volatility. Our results should not be distorted as this period of financial turbulence is outside of our sample. Over the sample under consideration, monetary policy decisions in Sweden and New Zealand have on all occasions been released earlier than the listing of interbank rates. Thus the standardised Riksbank and RBNZ surprise for a monetary policy decision taking place at day t is calculated as:

$$S_t^{MP,j} = \frac{i_t^{1M} - i_{t-1}^{1M}}{\sigma} \qquad (1)$$

where $S_t^{MP,j}$ represents the standardised monetary policy surprise at day t for country j (j=Sweden, New Zeal). i_t^{1M}, is the 1-month interbank rate at day t and σ is the sample standard deviation of the surprise components. Norges bank has throughout the

sample announced their decisions no earlier than 14.00 (local time). As a result, the surprise component for Norway is calculated as $i_{t+1}^{1M} - i_t^{1M}$ in eq. 1.

One caveat regarding the use of 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 coefficient 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, Figures 5 to 7 show scatter plots of target surprises using standard survey based data (when available) and the market based data (as described above).

[Figures 5-7 near here]

As can be 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 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 et al. (2007). Later on, Brand et al. (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 cannot be explained by the target surprise is defined as the PS:

$$\Delta IFR_t^k = \alpha + \beta TS_t^k + PS_t^k \qquad (2)$$

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

Extraction of macroeconomic data surprises

In order to increase the estimation efficiency and minimise omitted variable bias, the surprise components of the most important macroeconomic 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.[12]

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; and 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, Overby, and Sebestyén (2009). 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. Finally, a word of caution is warranted: even though we control for macroeconomic data releases which over time tend to exert a significant impact on bond yields, there are still market moving events that may influence bond yields. Such events can be firms' earnings releases, Treasury auctions, political events and so on.

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 equation (2) 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 i at time t, i_t^n can be expressed as:

$$i_t^n = 1/n\left[E\left(i_{1,t}\right) + E\left(i_{1,t+1}\right) \ldots E\left(i_{1,t+n-1}\right)\right] + \theta_{n,t} \qquad (3)$$

where $E_{1,t+i}$ is the one-period yield which markets, at time t, expect to prevail at time $t+i$. θ 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 a policy surprise) also has an impact on long-term interest rates. With respect to ten-year bond yields, however, the endogeneity issue should be deemed relatively small as it is derived from one small component in equation (3), namely the $E_{1,t}$ component. To account for this feature we add the five-year forward interest rate expected to prevail in five years' time to the dependent 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 expectations.

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 the 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 whether quantitative forward guidance has helped to anchor long-term inflation expectations, and the third whether a move towards 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 while regression analysis will be employed to tackle the two latter points. Throughout this 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' reactions to Norges bank's communication have changed after it decided to publish its 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 the 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 to which the public is able to anticipate 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 et al. 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. Figure 8 shows the unconditional mean of both target and path surprises for the three economies. As is evident from 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 those of 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.

[Figure 8 near here]

For Norges Bank, it seems that its short-term predictability improved after the introduction of the interest rate path. In fact, both target and path surprises declined significantly after November 2005. It should, however, be noted that the 2005 to mid-2007 period was characterised by a 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 consist of three components, a real rate component, an inflation expectation component and a premium demanded for investing 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 expectations five to ten years into the future as well as the term premia they demand over this horizon are broadly constant, changes in far-ahead forward rates should be related primarily to revisions in long-term inflation expectations, as seen through the eyes of investors (see Gürkaynak et al. 2005). Thus, if monetary policy (and other macroeconomic) surprises are unable to significantly move the yields onhis long-term horizon, this would provide evidence that market participants' long-term inflation expectations are well anchored.[13]

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, e.g. Ehrmann and Fratzscher (2007). We explore both mean and volatility effects of monetary policy surprises and macro news surprises on five-year forward rates.[14]

For completeness we also replicate this regression for five and ten year government bond spot rates. The benchmark case estimates the following mean equation:

$$\Delta r_t = \alpha + \beta \Delta r_{t-1} + \gamma_1 TS_t + \gamma_2 PS_t + \Phi X_t + \varepsilon_t \qquad (4)$$

where Δr_t 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:

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

$$\phi_3(\sigma_{t-1}^2) + \phi_4 DM_t + \phi_4 DX_t \qquad (5)$$

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 are revealed and zero otherwise). Two main results can be seen in Table 1. First, target and path surprises, across economies (and across samples in the case of Norway), have lower coefficient values and lower 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.

[Table 1 near here]

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 with findings for the United States found by Gürkaynak et al. (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' (page 425). 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 et al. (2006) who find evidence that Swedish and UK long-term inflation compensation embedded in bond yields has been insensitive to economic news during the period when the economies have operated under a clear inflation targeting mandate

(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 more strongly to the path surprise. From a tactical central bank communication perspective, this would open a way to exert a larger influence (i.e. greater 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 in steering the 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 announced the interest rate decision.

$$\Delta r_t = \alpha + \beta \Delta r_{t-1} + \gamma_1 TS_t + \gamma_2 TS_t D_t^{fguid} + \gamma_3 PS_t + \gamma_4 PS_t D_t^{fguid} + \Phi X_t + \varepsilon_t \quad (6)$$

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. Obviously,

the sample is relatively limited and the results should be interpreted accordingly. There are 34 occasions for New Zealand when an interest rate forecast was released, and 31 occasions for Sweden when an inflation forecast was released.

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).[15] The coefficient estimates suggest that the RBNZ can potentially obtain an enhanced leverage over medium term bond yields on the days 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 as normally. For Sweden, interest rates do not show any extra sensitivity on the days the Riksbank publishes its monetary policy report (see Panel B). Overall, these findings provide some mild support for the notion that publication of an interest rate path forecast may enhance the central bank's leverage over medium-term interest rates.

[Table 2 near here]

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. This paper assesses these hypotheses in the following ways. First, we test if the publication of an own interest rate path can enhance the predictability of monetary policy, i.e. help avoid 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 sensitivity of long-term domestic government bond yields (both spot and forward) to derived path and target surprises, we are able to evaluate if the publication of an interest rate path has anchored 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; and second, a comparative analysis for Norges Bank over two different sub-samples, when an interest rate forecast was published in the second sub-sample, but not in the first.

The main findings of the paper are the following. 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 Norges Bank reveals that policy surprises have become smaller after November 2005, when 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-term 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 more weakly to the target surprise and substantially more strongly 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 the publication of an interest rate path, may potentially 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, inflation-expectations anchoring 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 constant interest rate (CIR) or the market interest rate (MIR) approach in the construction of central banks' macroeconomic forecasts[16] and the establishment of a more forward looking framework for 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.[17] Also, publishing an own interest rate forecast might be interpreted by the public as an unconditional promise (Mishkin 2004, Goodhart 2009) or central banks might be unwilling to revise their path for reasons of prestige (Gersbach and Hahn 2008), which might impede required adjustments of the path to changes in economic conditions. These latter issues are difficult to test empirically. However, the fact, which we have documented in this paper, that the RBNZ has over time made quite sizeable revisions in its published interest rate path without causing major disruptions in the markets or suffering a loss in credibility points to a potentially limited relevance of these issues. Finally, there is the issue whether constructing a publishable interest rate path should be considered a pre-eminent issue

for central banks with scarce resources.[18] This potential caveat might, however, be qualified if fewer resources would need to be devoted to other ways of policy signalling when a path was published.[19]

Overall, the relevance of the various potential advantages and disadvantages of publishing an own interest rate path 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.

Notes

[1] Norges Bank started to publish an explicit policy rate path in November 2005. A 'strategy interval' for the policy rate four months ahead had been published since summer 2004.

[2] In 2007, Bank of England Deputy Governor Lomax (2007) stated that the Bank of England was considering publishing an own interest rate path, but more recent statements from the Bank of England's Monetary Policy Committe sound more dismissive. For instance, Bank of England Chief Economist Spencer Dale (2009) recently stated that "[t]he Committee's preferred approach is to describe its assessment of the outlook for output and inflation, and allow the public and markets to make their own assessment of the likely future path of interest rates."

[3] For a recent survey, see Blinder et al. (2008).

[4] For both the Swedish Riksbank and the Czech National Bank the period over which an interest rate path has been published is still too short to allow an empirical assessment of its effects. For the Riksbank there is, however, an interesting study by Andersson, Dillén and Sellin (2006) investigating the effect of the various communication tools of the Riksbank (e.g. speeches, release of the Inflation Report) on market interest rates for the period before quantitative forward guidance was adopted.

[5] Overall, there is strong evidence that the ability of financial markets to predict monetary policy has in general increased over the last decade, which provides evidence of the beneficial effects of the transparent approach to monetary policy adopted by central banks around the world in the recent past on the predictability of monetary policy. For a survey of the literature, see Blattner et al. (2008).

[6] An interesting finding of the literature on this subject is that macroeconomic news appear to have a stronger and more significant effect on long-term interest rates or far ahead forward interest rates in the US (Gürkaynak et al. 2005), than in the euro area (Brand et al. 2006, Beechey et al. 2007) or the UK and Sweden (Gürkaynak et al. 2007), which is interpreted as suggesting that inflation expectations are less anchored in the US than in these three other economies.

[7] 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.

[8] 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.

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

[10] 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.' (Rosenberg, 2007).

[11] See Goodhart and Lim (2009) for a recent empirical assessment of the (in)ability of central banks and markets to forecast the future path of policy rates.

[12] The data were obtained from Bloomberg and Haver DLX.

[13] 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.

[14] 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).

[15] This pattern is similar to that obtained by Swiston (2007) in an assessment of the implications of the issuance of FOMC statements on the effect of monetary policy surprises on US bond yields. He finds that the introduction of the statements led to a

reduction in the effect of the short-term monetary policy surprise and an increase in the surprise about the more distant prospective level of policy rates.

[16] See Goodhart (2009) for a thorough discussion of the alternative interest rate conditioning assumptions of central bank forecasts.

[17] This point was, however, challenged by Svensson (2003) who argues that agreeing on an interest rate path would not be more complicated than agreeing on an inflation or output growth forecast path. As a practical matter, he suggested letting each MPC member draw his preferred future interest rate path on paper and then taking the median of the individual paths.

[18] This point was made by Lars Heikensten in a comment on our paper at the 6th Norges Bank Monetary Policy Conference.

[19] Indeed, according to a comment made by Lars Svensson at the 6th Norges Bank Monetary Policy Conference and also a speech by Rosenberg (2007), the Riksbank makes less use of signalling via e.g. speeches and statements since it has been publishing its own policy path.

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Table 1 Baseline results for New Zealand, Sweden and Norway

Panel A: New Zealand

	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 New Zealand and Sweden

Panel A: New Zealand

	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 can be excluded from the model. For New Zealand, there are 34 occasions when an interest rate forecast was released and for Sweden 31 occasions when inflation forecast was released.

Figure 1: Key policy rate and interest rate paths for New Zealand, Norway and Sweden

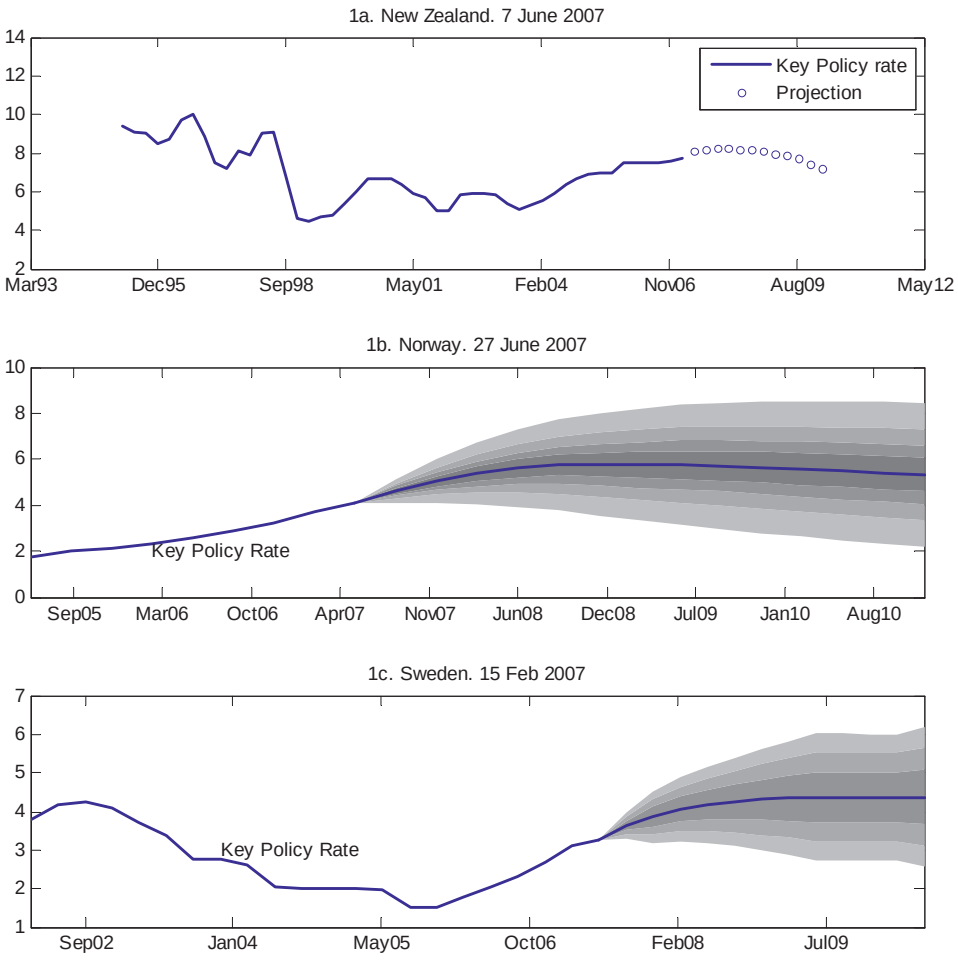


Figure 2: Track record for RBNZ own interest rate path
(January 1999 – January 2007)

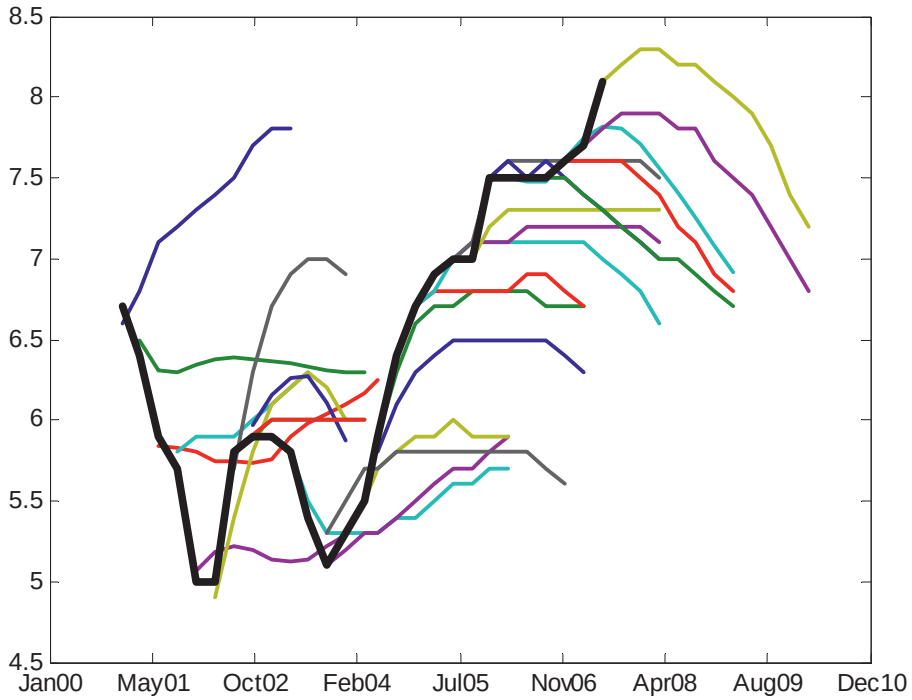


Figure 3: Track record for market based forecasts of Sveriges Riksbank repo rate *(January 1999 – January 2007)*

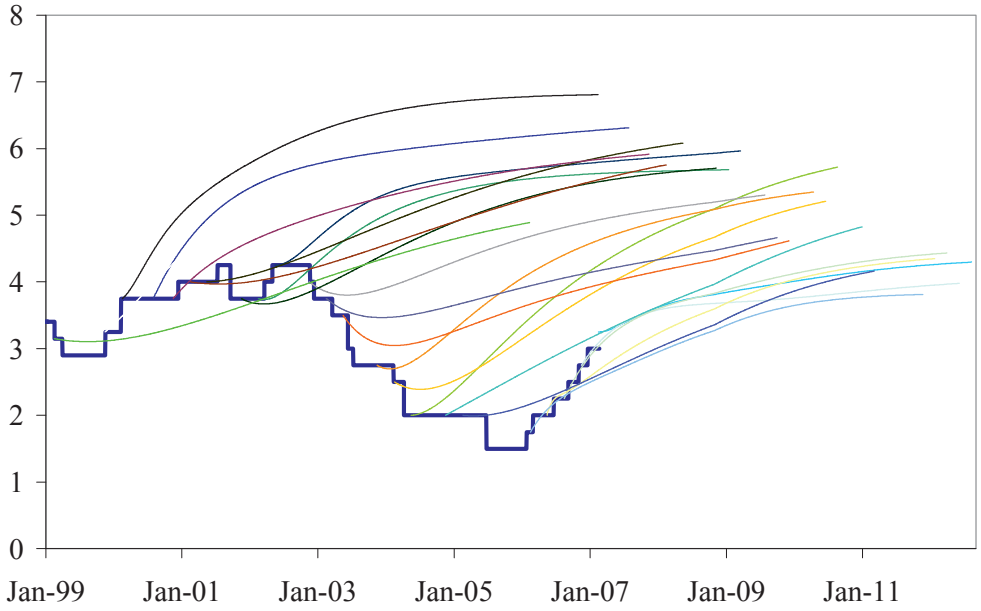


Figure 4: Riksbank repo rate forecast and market expectations in February 2007 *(in % p.a.)*

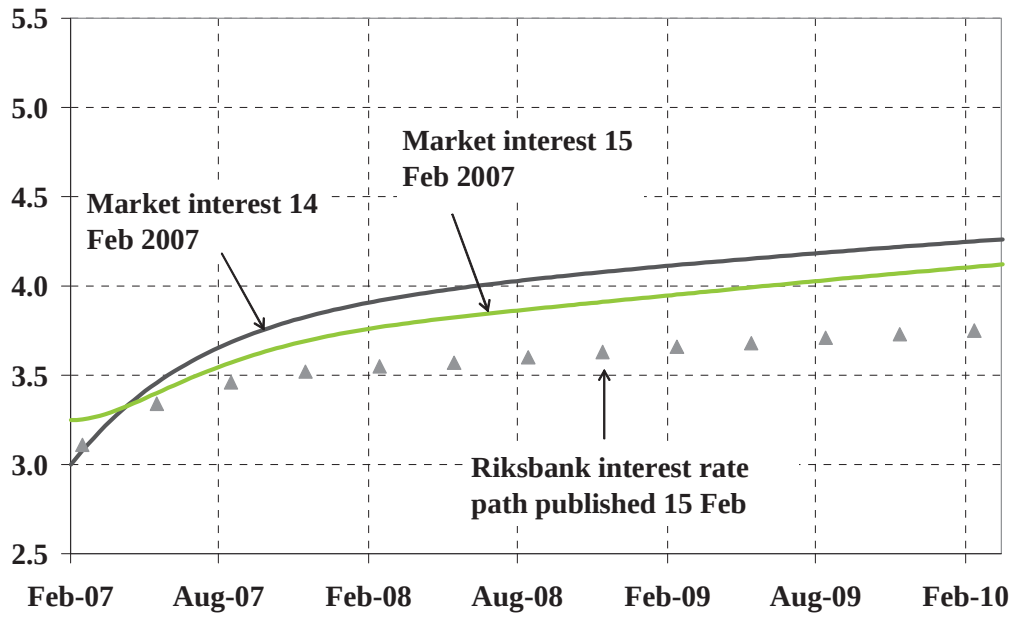


Figure 5: Survey based *(y-axis)* and marketd based *(x-axis)* measures of monetary policy target surprises for New Zealand

(in basis points, April 2001 – June 2007)

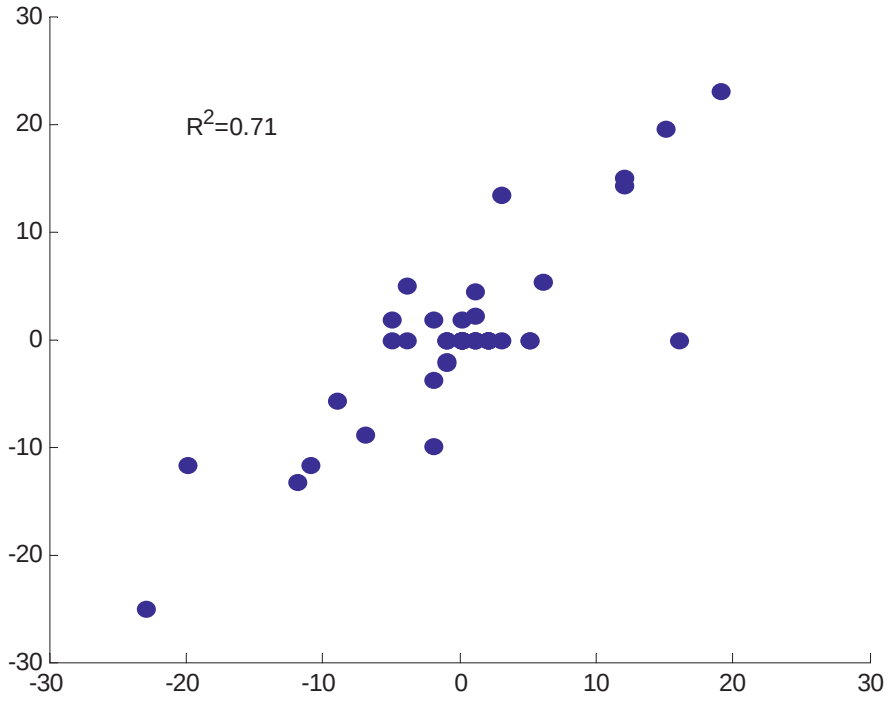


Figure 6: Survey based *(y-axis)* and market based *(x-axis)* measures of monetary policy target surprises for Norway

(in basis points, June 2003 – June 2007)

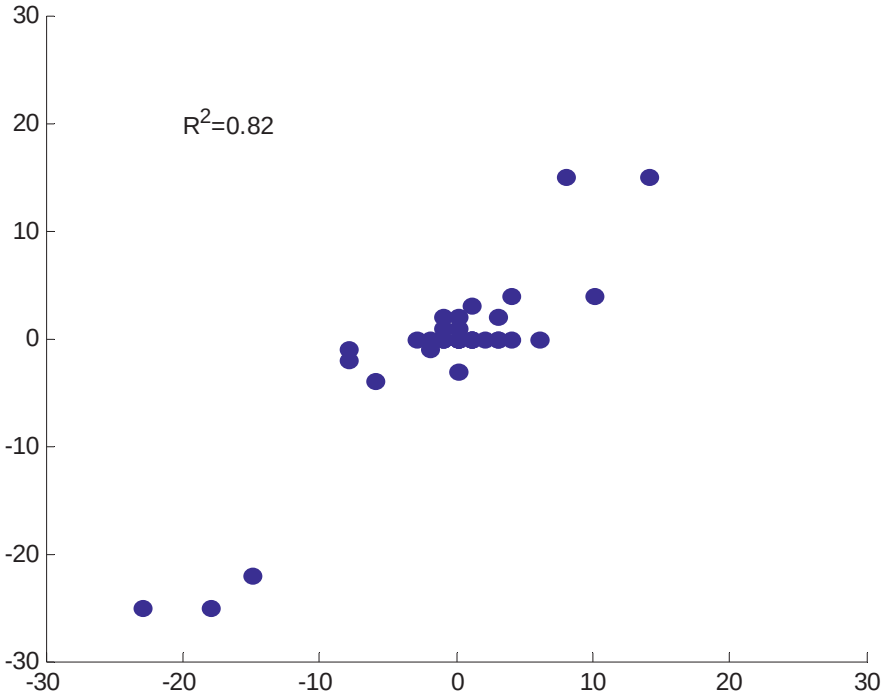


Figure 7: Survey based *(y-axis)* and market based *(x-axis)* measures of monetary policy target surprises for Sweden

(in basis points, October 1999 – June 2007)

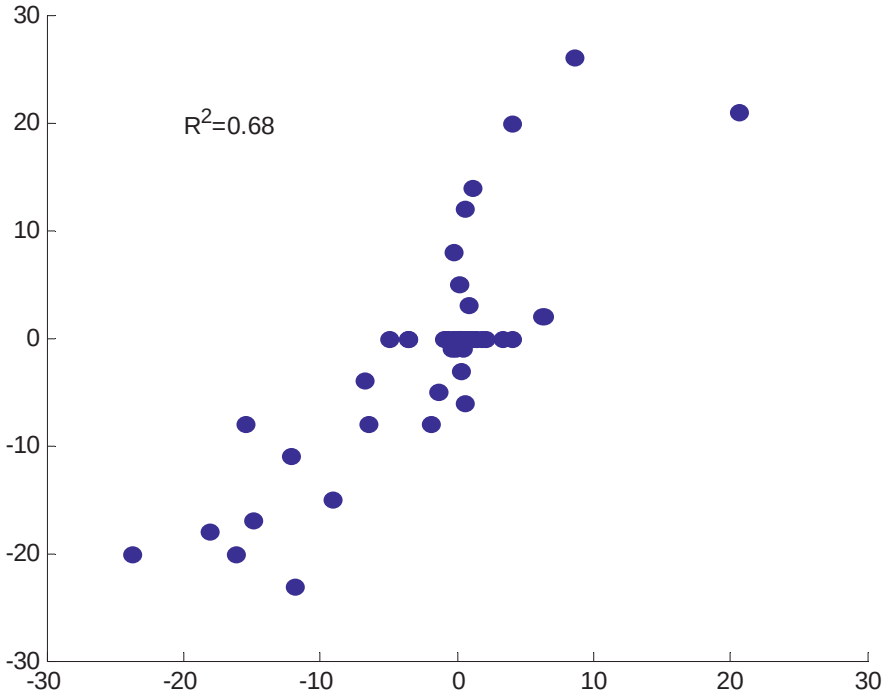
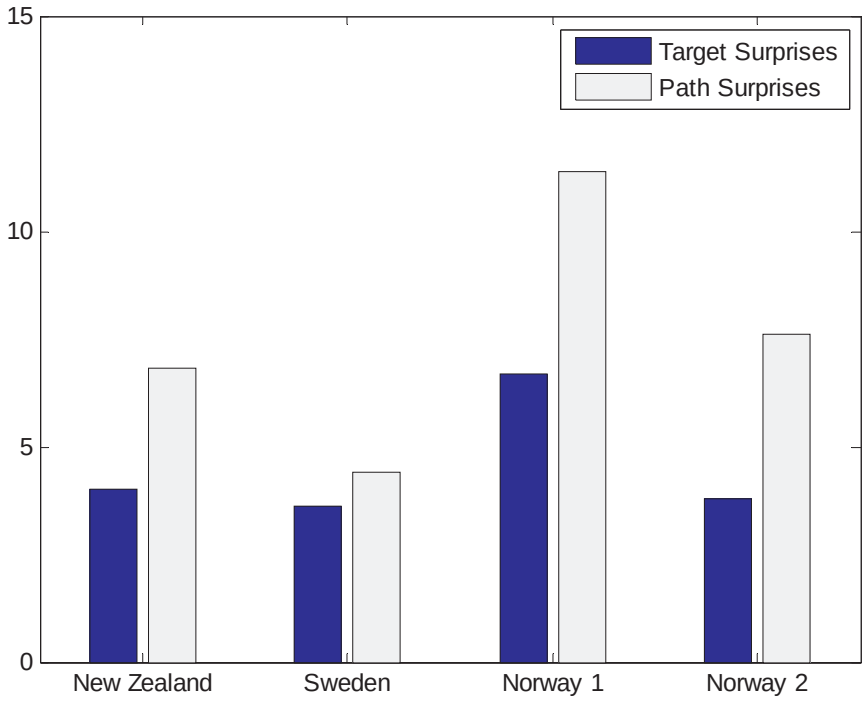


Figure 8: Average absolute target and path surprises of the Reserve Bank of New Zealand, the Riksbank and Norges Bank

(Sample period: for New Zealand and Sweden: January 1999 – January 2007, Norway 1: March 2001 – October 2005, Norway 2: November 2005 – June 2007)



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