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LEIF BRUBAKK,
SASKIA TER ELLEN
AND HONG XU

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Forward guidance through interest rate projections: does it work?

Leif Brubakk, Saskia ter Ellen and Hong Xu*

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Abstract

Based on high-frequency data for Norway and Sweden, we investigate to what extent explicit forward guidance from monetary policy makers, by means of publishing the path of expected future policy rates, affects the market yield curve. We summarise movements in the yield curve by two latent factors (the 'target factor' and 'market path factor'), which capture market participants' assessment of all relevant monetary policy communication made available on announcement days. We then show that information contained in the published interest rate path has a significant effect on the market path, and can explain up to 47% of the market path factor. Hence, we conclude that 'explicit' forward guidance in the form of publishing the interest rate path succeeds in moving markets in the desired direction. Furthermore, our results show that central bank and market revisions of interest rate expectations are strongly correlated. This suggests that market participants to a large extent understand the monetary policy reaction pattern.

Keywords: monetary policy, forward guidance, interest rates

JEL classification codes: E43; E44; E52; E58; G12

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1 Introduction

Although the term *forward guidance* is relatively new, the idea that central banks, through various means of communication, can affect expected interest rates is not. Various forms of forward guidance have been used since the late 1990s. Traditionally, forward guidance amounted to verbal, often subtle, statements about future intentions. In general, forward guidance refers to any communication from the central bank about the future path of policy rates.

In this paper we contribute to the literature on forward guidance by providing evidence on the effectiveness of publishing interest rate forecasts. We start by taking a broad approach and evaluating how monetary policy actions and communication in general affect the yield curve for Norway and Sweden. Based on the methodology developed by Gürkaynak et al. (2005b) we distinguish a 'target' and 'market path' factor from yield curve responses after monetary policy announcements. The second factor can be interpreted as forward guidance as *perceived* by market participants. We are, however, also interested in the forward guidance as *intended* by the central bank. To this end, we utilise data on published interest rate forecasts by Norges Bank and Sveriges Riksbank, the Norwegian and Swedish central banks, respectively. We show that information contained in the published interest rate path has an effect on the market yield curve, and can explain up to 47% of the market path factor. Market participants seem to understand the monetary policy reaction to a large extent, as their revisions are highly correlated with the revisions of the central banks.

In the aftermath of the global financial crisis, policy rates in many countries were reduced to levels close to the effective lower bound, obstructing further stimulus through conventional means. This lead central banks to look for alternative tools to stimulate the economy, like forward guidance and quantitative easing. In December 2012, the Federal Reserve announced that it would not raise interest rates as long as the unemployment rate was above 6.5% and inflation remained below 2.5%. The Bank of England followed suite less than a year later, conditioning the future interest rate path in a similar fashion on developments in the unemployment and inflation rates. The Fed also started publishing plots of each FOMC member's judgment on the appropriate interest rate level both in the medium and longer run. A yet more explicit form of forward guidance, namely publishing interest rate forecasts, has been used as a policy tool in a handful of countries for several

years. The Reserve Bank of New Zealand (RBNZ) lead the way in 1997, followed by Norges Bank in 2005, Sveriges Riksbank and the Bank of Israel in 2007, and the Czech National Bank in 2008[1]. This paper investigates the effectiveness of such explicit forward guidance in shaping both short- and long-term interest rate expectations.

Conventional monetary policy potentially influences the whole yield curve through the expectations channel. In a perfect world, where all agents in the economy share the model of the central bank and fully understand its reaction pattern, there will in principle be no need for any forward guidance. In real life, however, these conditions are not necessarily fulfilled. Hence, transparency regarding policy intentions, if credible, could reduce uncertainty regarding future policy rates and help to align market expectations with policy intentions (Bernanke, 2013). The concept of forward guidance fits well with modern monetary theory, which stresses the expectation channel of monetary policy. Woodford (2003) asserts that monetary policy basically boils down to the "management of expectations". By affecting private sector expectations in the desired direction, the central bank can achieve its objectives in a more efficient manner. This is one of several rationales for forward guidance.[2] Eusepi and Preston (2010) show that just communicating an inflation target is not enough to stabilise inflation expectations and central banks also need to communicate their policies as to how to get to that target. Under certain conditions, optimal policy, i.e. one that minimises the volatility in the target variables, is attained when the central bank can credibly commit to a conditional future path for the policy rate. Hence, according to Woodford (2005) and Svensson (2006, 2009), publishing the central bank's own interest rate forecasts will make the commitment strategy more credible, and thereby more efficient. This is formally supported by Rudebusch and Williams (2008), who show within a simple New Keynesian model that publication of interest rate projections better aligns the expectations of the public and the central bank when private agents have limited knowledge of the central bank's preferences.

So why do most central banks seem hesitant to reveal their future policy intentions? One argument put forward by Mishkin (2004) and Goodhart (2009), is that publishing

[1]With the exception of RBNZ, probability bands are also provided to indicate the uncertainty surrounding the central projections.

[2]Other reasons are related to transparency and accountability. Publishing the interest rate path, together with forecasts for inflation and activity, enhances the understanding of the monetary policy reaction pattern. Furthermore, it also clarifies the trade-off between the various target variables, making it easier for external observers to evaluate monetary policy.

the central bank's interest rate forecast might lead private agents to interpret the path as an unconditional promise and not a conditional forecast. Another concern, raised by Morris and Shin (2002), is that private agents could put too much weight on public information from the central bank relative to private information. In that case, more public information, like e.g. information on the expected path of future policy rates, could reduce welfare, even in the case where the central bank projections are believed to be very accurate. Using a very different set-up, but also assuming heterogeneous and imperfect information, Gosselin et al. (2008) argue that there could be a case against publishing future expected policy rates when the precision of central bank information relative to private-sector information is low. To what extent publishing the interest rate path is welfare-improving might also depend on the institutional framework of the central bank. Walsh (2007) demonstrates that the optimal degree of transparency in a New Keynesian model depends on the central bank's ability to forecast demand and supply shocks, while Brzoza-Brzezina and Kot (2008) show that the benefits of publishing interest rate forecasts are marginal once other macroeconomic forecasts are provided. Blinder et al. (2003) argue that agreeing on a specific interest rate path could be challenging in individualistic committees like e.g., the MPC at the Bank of England. Finally, some have warned that the central bank could stick to the published path beyond what is dictated by optimal commitment. This point is formalised in Gersbach and Hahn (2008), who find that the announcement of future interest rates could be socially detrimental.

Compared to the theoretical literature, there are relatively few empirical studies investigating the merits of publishing interest rate projections.[3] One strand of literature focuses on how predictability of interest rates is affected by the publication of interest rate forecasts. An example is Kool and Thornton (2012), who test whether forward guidance improves market participants' ability to forecast future short-term and long-term rates relative to several benchmarks. They find some evidence, although weak, of improved forecast accuracy over relatively short forecast horizons in New Zealand, Norway, and

[3]The main bulk of empirical studies on forward guidance have focused on the merits of transparency in terms of having an explicit inflation target, verbal communication, voting records etc. Chortareas et al. (2002), Cecchetti et al. (2002), and Geraats et al. (2006) find that transparency makes monetary policy more credible and helps achieving the ultimate policy objectives. There is also a number of studies on the predictability of monetary policy. Evidence of improved monetary policy predictability due to transparency is provided by Muller and Zelmer (1999), Haldane and Read (1999), Poole and Rasche (2003), Fracasso et al. (2003), and Bernoth and Von Hagen (2004).

Sweden after these countries started publishing interest rate paths.[4]

Even less attention has been devoted to investigating the effects on market rate movements from explicitly publishing central bank policy projections. Ferrero and Secchi (2009) study the effects of announcing future policy intentions, focusing on the Reserve Bank of New Zealand. They find that the volatility in short term money market rates on the days of interest rate decisions has decreased after the introduction of qualitative and quantitative announcements on future policy intentions. Comparing New Zealand to the US and Euro area, Moessner and Nelson (2008) find that communication in general influences market rates. Moreover, they find no support for the claim that interest rate forecasts impair the functioning of financial markets. Andersson and Hofmann (2009) test various claims related to the merits of explicitly communicating the future course of monetary policy, based on the experience of New Zealand, Norway and Sweden up until 2007. Due to data limits, they can only study the effect on yields of publishing the interest rate path for New Zealand. They find a significant effect on five-year bond yields, but no effect on 10-year yields.

The focus of this paper is to study the extent to which the intended forward guidance, as revealed by the published interest rate path, is transmitted to market rates after the announcement. In some sense, we are interested in measuring and quantifying the entropy (i.e. expected content) of the information as viewed by market participants. First, based on data for Norway and Sweden, and equipped with the methodology developed by Gürkaynak et al. (2005b, hereinafter GSS), we analyse the impact of central bank actions and communication on various interest rates. Similarly to GSS, we distinguish two factors that can explain a substantial part of the variation in interest rates around monetary policy announcements.[5] By construction, we can interpret the first factor as the rate surprise. The second factor, which we label the 'market path factor', can be interpreted as summarising all relevant forward guidance communication as perceived by market participants (including the published interest rate path). To what extent the market path factor corresponds to the actual policy intentions is, however, an open question. To address this issue, we construct two alternative measures of forward guidance based on the published interest rate path, and compare these alternative measures to the market path

[4]Interestingly, preliminary results by Natvik et al. (2017) find very limited evidence for improved forecasting ability due to the publication of path forecasts.

[5]This is also the approach followed by Andersson and Hofmann (2009).

factor. Both measures can explain movements in the market yield curve, and also the market path factor identified using the GSS approach.[6] Hence, we conclude that market participants in Norway and Sweden to some extent move their interest rate expectations in the direction implied by the published interest rate path beyond what could be predicted from the systematic part of monetary policy and from surprise changes in the current policy rate. Furthermore, our results show that central bank and market revisions of interest rate expectations between interest rate announcements are strongly correlated. This suggests that market participants to a large extent understand the monetary policy reaction pattern and how new information affects monetary policy.

The rest of this paper is set up as follows. Section 2 covers our methodology, and Section 3 describes our dataset. Sections 4.1 and 4.2 show the results of our factor estimations, and Section 4.3 displays the results from analysing the published interest rate projections. Section 5 concludes.

2 Methodology

2.1 Forward guidance in a communication theory framework

Communication theory, as developed in Shannon (1948), can be a useful tool in evaluating central bank communication in general and forward guidance in particular. In the basic set-up, there is a 'sender' that transmits a 'message', i.e. some piece of information, to a 'receiver'. The information is passed through a 'channel' from the sender to the receiver. Typically, the channel will be polluted by 'noise', which to varying degrees distorts the signal transmitted by the sender. In our context the central bank represents the sender and the role of the receiver is played by the market participants. On the day of an interest rate announcement, the central bank has a message for the external observers on the forward path of policy rates.

In the two countries we consider in this paper, this message is conveyed through a monetary policy report and a press conference, which are the relevant channels. Both Norway and Sweden publish the expected three month money market rates over a horizon of up to 16 quarters. Both central banks indicate that, conditional on other future assessments, the future policy rates can be expected to be in line with the published path.

[6] In line with what Svensson (2015) labels the 'credibility' of an interest rate path.

However, there are many reasons why market rates would not necessarily fully adjust to the published interest rate path. Market participants might not find the path to be credible, or have a different assessment on the future course of key economic variables. Furthermore, the interest rate path is not the only piece of information communicated in the monetary policy report or on the press conference. In addition, the overall information set also includes forecasts and assessments on other relevant variables, a thorough discussion of the deliberation underlying both the current interest rate decision and the forward path, and an assessment of uncertainty attached to the forecasts. These accompanying pieces of information could be unclear or inconsistent with the interest rate path message.

One goal of this paper is to measure the extent to which forward guidance in the form of an interest rate path transmits to market rates. In communication theory, the information content of a message, as perceived by the recipient, is often referred to as entropy, and it contrasts the portion of the message that is predictable. Hence a second goal of the paper is to shed some light on the extent to which the published path is perceived by market participants a priori, i.e. to what extent it is predictable. The remainder of this section describes how we go about identifying both the market interpretation of the surprise content of the published path, as well as the measures used to characterise the forward guidance content intended by the central bank.

2.2 A 'target' and 'market path' factor

The current literature has various ways of identifying monetary policy shocks (i.e. unexpected changes in monetary policy). In this paper, we use high frequency data around announcements to identify monetary policy surprises and the corresponding effects on various market yields. The idea behind this approach is as follows. Interest rate instruments reflect market participants' expectations about future interest rate settings. If we use an instrument which has a horizon short enough to only include the next interest rate meeting, we can extract the market's expectation of the central bank's rate setting at this next meeting. A surprise in the rate setting can then be measured by looking at the change in this short-horizon instrument from just before the meeting until shortly after the meeting. The window at which one measures this surprise should be short enough so as to be sure one only measures the response to the rate setting (rather than other

events or new information hitting the market in the same time window), but long enough to allow markets to digest the information. Theoretically speaking, in a fully efficient market, we would expect these change to be rather instantaneous. However, in practice, interpreting the information may take some time, and therefore the window should not be too short.

Changes in the current key policy rate will have an effect on the current money market rate, but may also impact longer horizon rates and other asset prices. However, it is not only the key policy rate that affects the longer term rates. Besides setting the rates, central banks often also communicate about the state of the economy and potential future actions. This communication affects market participants' expectations of future rate changes. The changes in long-term rates in response to announcements are therefore a combined effect of changes in the current key policy rate and expectations of future policy rates.

In order to distinguish between the effects of changing the current policy rate ("monetary policy shock") and changing expectations of future policy rates ("market path surprise "), we closely follow the factor-based methodology developed by Gürkaynak et al. (2005b). Using factor analysis, one can summarise a set of correlated observed variables by a smaller set of independent unobserved variables: factors. These factors are the common components of the observed variables:

$$X = F\Lambda + \varepsilon \tag{1}$$

In Equation (1) X is a $r \times c$ matrix consisting of the variables we want to summarise - the responses, around monetary policy announcements, in money market instruments with less than approximately 1 year to maturity[7] -, with r representing the number of interest rate meetings and c the number of interest rate instruments used. F is a matrix with r rows and $f \leq c$ columns. We performed a rank test (as in GSS) to test for the number of factors, and find that two latent factors are sufficient to explain the common variation of the instruments used.[8]

In order to give a structural interpretation of the factors, we need to 'rearrange' them

[7]In practice, the fourth FRA contract will exceed the one-year horizon a bit.

[8]Sweden is a bit more sensitive for the window chosen, but as can be seen from the factor diagnostics in Section 4.1, the two factors explain almost all of the variation in the money market rates around announcements. For Norway, including swaps with maturities of two and five years in X, there is some evidence of a third factor. See Section 4 for a more elaborate discussion of this potential third factor.

so that one of them can be interpreted as the surprise in the current policy rate and the other one as the surprise in the future path, labeled as the 'market path factor'. Following GSS, we rotate the factors by multiplying them with a rotation matrix U:

$$Z = FU \tag{2}$$

This rotation matrix is chosen such that the first column of Z is interpreted as the 'target' factor, and as such summarises the impact of changing the policy rate, and the second column is interpreted as the 'market path' factor: the impact of all new information deemed relevant to the future path of interest rates. The main identifying assumption for this is that the key policy rate surprise should be correlated with the target factor, but not with the market path factor. The methodology is explained in detail in GSS. In the final step, we regress the returns of the different market rates over the same time window as identification of MP shocks on the two factors, to evaluate the relative effects of monetary policy shocks and market path surprises on various yields. The factors have been re-scaled as in GSS for ease of interpretation and comparison. More precisely, the target factor is calibrated so that a surprise in the key policy rate corresponds one-to-one with the target factor. When this is done, the coefficients in front of the target factor can now be interpreted as a basis points interest rates change per 1 basis point surprise change in the one month interest rate. Furthermore, we re-scale the path factor such that the target factor and the path factor have the same impact on the three-month money market rate effective in approximately one year's time, here given by the fourth FRA contract. In such a way it is more straightforward to compare the relative size of coefficients on the target and path factor for interest rate instruments with a shorter or longer horizon than one year.

2.3 Measures of forward guidance

In this section we clarify what we mean by forward guidance as intended by the central bank. Most preceding studies see forward guidance through the eyes of financial market participants. Hence, the focus is more on the perceived forward guidance, i.e. from the point of view of the receiver of information. Here we argue that it is important to incorporate forward guidance in terms of the intended message of the central bank, as

represented by the published interest rate path. If we measure forward guidance based on market responses, we cannot say if the yields have been moved in the *intended* direction. In other words: we cannot conclude that forward guidance was actually successful. This is generally challenging, as it is not always clear what the intention of the central bank is. However, for central banks that publish interest rate forecasts, we can safely assume that the intention is to 'guide' market expectations toward the published path.

Our measures of forward guidance are to some extent motivated by the concept of entropy. Hence we abstract from the part of the interest path that is predicted by market participants. Furthermore, we also need to control for the actual rate surprise, and the effect it has on the yield curve. Hence, in our definition of 'forward guidance' we do not include changes in the path that are due to adjustments in the current policy rate. Instead of filtering out this effect in the measures themselves, we control for it in the regressions.

We propose two different, although related, measures of forward guidance. The first measure is simply the difference (gap) between the central bank's published path and the market's path on the day (close) before the publication of that path, denoted $R^{gap}_{m,t+n}$ and defined as

$$R^{gap}_{m,t+n} = R^{CB}_{m,t+n} - R^{MKT}_{m,t+n} \tag{3}$$

where $R^{CB}_{m,t+n}$ denotes the projected average three-month money market rate in quarter $t+n$ as revealed by the central bank at interest rate meeting m (where m is a date in quarter t).[9]

The second measure which we shall denote $path^{SURP}_{m,t+n}$, is the difference between the revision of the expected path from one meeting to the next as revealed by the central bank and the market's revision of future expected money market rates shortly *prior* to the announcement.

$$path^{SURP}_{m,t+n} = R^{CB}_{m,t+n} - R^{CB}_{m^-,t+n} - \left(R^{MKT}_{m,t+n} - R^{MKT}_{m^-,t+n}\right) \tag{4}$$

where the subscript m^- refers to a point in time shortly after the previous interest rate announcement.

[9]This can be interpreted as a proxy for the surprise component of the level of the path, although there can be other reasons that the level of the market's and the central bank's path are (structurally) different.

Hence, $R^{MKT}_{m,t+n} - R^{MKT}_{m^-,t+n}$ defines the market revision from shortly *after* the last published interest rate path to shortly *prior* to the most recently published interest rate path. This can be interpreted as a measure of the forecastable part of the interest rate path. In other words, this is the change in market rates following the arrival of new information on relevant macro variables. Thus, one measure of policy predictability would be the correlation between $R^{MKT}_{m,t+n} - R^{MKT}_{m^-,t+n}$ and $R^{CB}_{m,t+n} - R^{CB}_{m^-,t+n}$.[10]

3 Data

As far as possible, we use the same (type of) market interest rates to measure the target and path factor on the one hand, and their impact on several long-term yields on the other hand.

Table 1: Factsheet sample countries

	Norway	Sweden
Inflation targeter since	2001	1993
Publish path since	2005	2007
No. meetings p/y (interval)	[6-10]	[6-9]
Average no. days between meetings	46	52
No. published paths p/y (interval)	[1-4]	[4-6]
No. of MPRs /*plus MPUs for Sweden p/y (interval)	[3-4]	[3-6]

Notes: This table presents relevant information on the central banks in our sample. Whereas Norges Bank only publishes Monetary Policy Reports (MPRs), Sweden also earlier published Monetary Policy Updates (MPUs) at meetings without an MPR.

Table 1 gives an overview of the two countries in our sample and some relevant descriptive information. Our data sample starts in 2001, when Norges Bank introduced inflation targeting. The dataset is constructed with data ranging from 15-minutes to one-day frequencies, obtained through Thomson Reuters. For the benchmark case, we concentrate on a 15-minute window for measuring the monetary policy surprises as used in Section 4.1, and the one-day window for the rest of the analyses, but we also perform robustness checks relying on shorter windows for the latter.[11]

We use data on money market rates up to one year (forward Rate agreements) and swap rates (two, five, and 10 years). Forward rate agreements reflect expectations of market participants of the three-month money market rate on a specific date in the future.

[10] See Section 4.3 for these results.

[11] The results are qualitatively very similar, but coefficients differ in size for the various windows. We do not report the results due to space limitations, but they are available upon request.

More precisely, the first FRA (hereafter FRA1) reflects the expected money market rate on the first upcoming IMM-date, FRA2 for the second upcoming IMM-date, etc.[12] On the contrary, swap rates reflect the expected average over the contract period. We use swap rates rather than government bond yields for our analysis of long term rates, due to the limited size and liquidity of the Norwegian government bond market (particularly at the beginning of our sample).

Preferably, we would like to use a one-month OIS/futures contract to extract unexpected changes in the key policy rate. However, Norway does not have an OIS or interest rate futures market, and the Swedish series is too short. Hence, we need to proxy the key policy rate surprise by using other measures. We therefore construct a synthetic one-month interest rate instrument by using forward exchange rates (USDNOK and USDSEK) in combination with covered interest parity (CIP):

$$\frac{F_t}{S_t} = \frac{1 + r_t^{us}}{1 + r_t^{nor}} \tag{5}$$

We have data on F_t (the one-month forward USDNOK exchange rate), S_t (the spot USDNOK exchange rate), and r_t^{us} (the one-month US interest rate), and can extract r_t^{nor} (the one-month Norwegian interest rate) based on the above parity condition. We do the same for Sweden (with USDSEK). As there has historically been more than 1 month between interest rate meetings, the one-month interest rates only reflects expectations about the current key policy rate setting.[13]

Regarding the data for the forward guidance as intended by the central bank, we use the announced interest rate paths as they appear in monetary policy reports published on the relevant dates. The published paths in both Norway and Sweden refer to the average three-month money market rates in the future calender quarters over the whole forecast horizon, which varies to up to between 12 and 16 quarters.[14]

Tables 2 and 3 show descriptive statistics for our variables of interest. Starting with Norway, we see that both the mean (of absolute values) and standard deviation in surprise

[12]The IMM-dates are the third Wednesday in March, June, September and December

[13]Note that in a few cases this condition is not met. On these occasions, the key policy rate surprise that we identify not only measures the surprise in the current rate setting, but also (with a much lower weight) the surprise in the outlook for the next meeting. We still prefer this over using shorter term forward rates due to the lower quality of data available to us for these contracts.

[14]For the periods before the two countries started publishing money market rates, we use the published policy rates.

changes around interest rate meetings decreased after Norges bank started publishing the interest rate path (2005). This is true for all maturities. In Sweden however, the opposite is true. Part of this could be due to the fact that observations recorded during the financial crisis implicitly get a higher weight in the descriptives calculated for Sweden.

Table 2: Descriptive statistics Norway

Norway	Before 2005			After 2005		
	Mean	**St. dev.**	**Obs.**	**Mean**	**St. dev.**	**Obs.**
MP Surprise	0.0742	0.0951	40	0.0518	0.0708	84
FRA 1	0.0825	0.0968	40	0.0548	0.0644	84
FRA 2	0.1025	0.1042	40	0.0581	0.0597	84
FRA 3	0.1061	0.0942	40	0.0585	0.0527	84
FRA 4	0.1043	0.0893	40	0.0583	0.0547	84
2y Swap	0.0839	0.0735	40	0.0498	0.0440	84
5y Swap	0.0541	0.0487	40	0.0368	0.0307	84
10y Swap	0.0368	0.0342	40	0.0288	0.0236	84
5y Swap 5y ahead	0.0291	0.0246	40	0.0281	0.0195	84

Notes: This table presents descriptive statistics for Norway for a split sample. Means are based on absolute values. The monetary policy surprise is measured based on a 15-minute window; the rest of the table shows statistics for variables measured over a one-day window. Columns 2-4 show statistics for the sample between 2001 and 2005, which is when Norges Bank had already adopted inflation targeting, but was not publishing interest rate projections yet. Columns 5-7 show statistics for the sample between 2005 and 2016.

Table 3: Descriptive Statistics Sweden

Sweden	Before 2007			After 2007		
	Mean	**St. dev.**	**Obs.**	**Mean**	**St. dev.**	**Obs.**
MP Surprise	0.0372	0.0560	43	0.0554	0.0885	63
FRA 1	0.0249	0.0281	43	0.0596	0.0915	63
FRA 2	0.0302	0.0256	43	0.0570	0.0699	63
FRA 3	0.0324	0.0249	43	0.0579	0.0659	63
FRA 4	0.0334	0.0234	43	0.0557	0.0666	63
2y Swap	0.0312	0.0230	43	0.0535	0.0597	63
5y Swap	0.0287	0.0187	43	0.0437	0.0366	63
10y Swap	0.0219	0.0180	43	0.0305	0.0251	63
5y Swap 5y ahead	0.0273	0.0216	43	0.0271	0.0273	63

Notes: This table presents descriptive statistics for Sweden for a split sample. Means are based on absolute values. The monetary policy surprise is measured based on a 15-minute window, the rest of the table shows statistics for variables measured over a one-day window. Columns 2-4 show statistics for the sample between 2001 and 2007, which is when the Riksbank had already adopted inflation targeting, but was not publishing interest rate projections yet. Columns 5-7 show statistics for the sample between 2007 and 2016.

4 Analysis and results

The set-up of this section is as follows. In Section 4.1, we analyse the effect on the yield curve of a monetary policy surprise as measured by the change in our synthetic one-month interest rate from the time of the announcement until 15 minutes after the announcement. After we have established that these effects are sizable, but strongly declining over the horizon and maturity of the instruments, we measure the effect of the second component that drives rates on days of monetary policy announcements, forward guidance, by a 'market path' factor, in Section 4.2. Although actions of central banks give some guidance, as they teach market participants about the central bank's reaction function, most of the guidance will follow from the press conference and the publication of a monetary policy report. The event window is therefore increased from 15 minutes to a day to capture these effects. We find that the market path factor explains an increasing share of the variation in interest rates on announcement days for longer horizons. In order to understand whether this *perceived* forward guidance is in line with the *intended* forward guidance by the central banks, we analyse the relation between interest rates, the 'market path' factor, and the unexpected change in the central banks' interest rate projections in Section 4.3

4.1 Monetary policy surprises

Before turning to the underlying factors, we are interested in evaluating the impact of a surprise in monetary policy actions on the yield curve. To this end, we regress the change in various interest rates on the policy rate surprise, measured as described in Section 3 ('monetary policy shock'):

$$\Delta y_t = \alpha + \beta \Delta x_t + \varepsilon_t \tag{6}$$

In the above equation, Δy_t is the change in both forward rates and swap rates and Δx_t is the rate surprise.

The results of this regression can be found in Tables 4 and 5. The coefficients can be interpreted as percentage points changes in market rates from a 1 percentage point surprise change in the key policy rate. We can see that a surprise change in the key policy rate has a significant and economically meaningful impact on both short and long interest

Table 4: Monetary policy surprises and market rates - Norway

	Constant	**MP surprise**	**adj. R2**
FRA 1	-0.0021	0.6651***	0.60
	[0.0048]	[0.07814]	
FRA 2	-0.0026	0.6621***	0.52
	[0.0056]	[0.0810]	
FRA 3	-0.0020	0.6154***	0.46
	[0.0059]	[0.0693]	
FRA 4	-0.0092	0.35705***	0.36
	[0.0067]	[0.0655]	
2y Swap	-0.0058	0.5525***	0.45
	[0.0054]	[0.0728]	
5y Swap	-0.0062*	0.3910***	0.45
	[0.0038]	[0.0544]	
10y Swap	-0.0075**	0.2206***	0.29
	[0.0030]	[0.0426]	
5y Swap 5y ahead	-0.0087**	0.0491	0.00
	[0.0041]	[0.0648]	

Notes: This table shows results from estimating Equation (6) for Norway. *,**,*** denote significance at 10%, 5%, and 1%, respectively. Newey-West standard errors are given in brackets.

Table 5: Monetary policy surprises and market rates - Sweden

	Constant	**MP surprise**	**adj. R2**
FRA 1	-0.0021	0.5444***	0.60
	[0.0030]	[0.1176]	
FRA 2	-0.0047	0.5824***	0.62
	[0.0039]	[0.0835]	
FRA 3	-0.0056	0.5369***	0.55
	[0.0042]	[0.0823]	
FRA 4	-0.0036	0.3830***	0.24
	[0.0054]	[0.1349]	
2y Swap	-0.0057	0.4899***	0.57
	[0.0038]	[0.0556]	
5y Swap	-0.0067*	0.3152***	0.39
	[0.0034]	[0.0452]	
10y Swap	-0.0050**	0.1474**	0.25
	[0.0022]	[0.0295]	
5y Swap 5y ahead	-0.0033	-0.0217	-0.01
	[0.0028]	[0.0612]	

Notes: This table shows results from estimating Equation (6) for Sweden. *,**,*** denote significance at 10%, 5%, and 1%, respectively. Newey-West standard errors are given in brackets.

rates. The effects are stronger and the explanatory power higher for the shortest end of the curve, which makes sense given the uncertainty further out on the curve. We note that the interest rate sensitivity appears to be almost identical across the two countries.

4.2 Monetary policy and forward guidance: factor analysis

We now move to the rotated factors based on day-long windows and derived using the approach outlined in Section 2. Figure 1 gives a graphical representation of the resulting target and path factors for Norway and Sweden.

For Norway there are three periods with increased volatility in the target factor; the start of the sample, during the financial crisis, but also at the end of the sample. In Sweden, the surprises seem to be more evenly distributed over the sample, except possibly from a slight increase during the financial crisis, which would be expected. Interestingly, the target factor seems to have an upward bias in the period after the financial crisis, indicating that more often than not market participants have underestimated the key policy rate.

We can observe that the order of magnitude of both factors is similar in the two countries. In Norway there seems to be some slight indication that the variance of the forward guidance factor is diminishing over the sample period. This does not appear to be the case for Sweden. Furthermore, in Sweden it seems that in the latter part of the sample, market participants expected a higher interest rate path more often than a lower path.

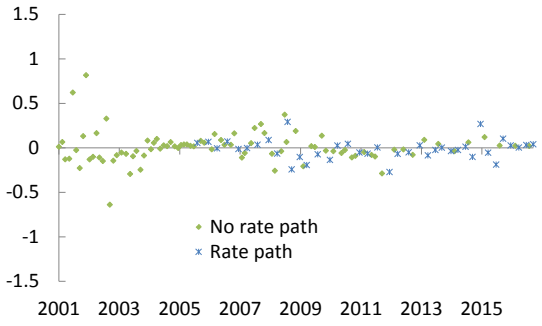
We now turn to analysing the effects of monetary policy and forward guidance shocks on interest rates. The rates we consider are the same as in the preceding section.

$$\Delta y_t = \alpha + \beta_1 Z_{1,t} + \beta_2 Z_{2,t} + \varepsilon_t \tag{7}$$

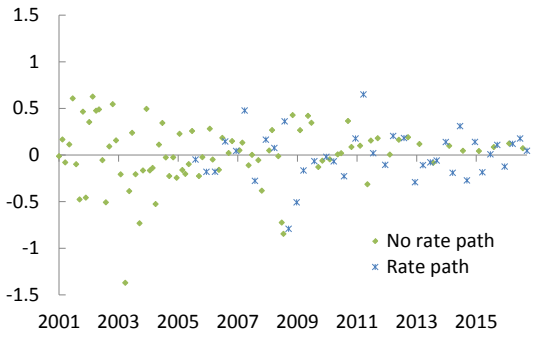
In the above equation, $Z_{1,t}$ represents the target factor, while $Z_{2,t}$ represents the path factor. In the following analysis, we are interested in finding out how much of the variation can be explained by the factors and how large the impact of the 'path' factor is compared with the 'target' factor for different yield maturities. We start by presenting the results for the FRA-contracts that are part of the information set when extracting the factors. Hence, this is merely a way to show that the two factors can account for almost all the

Figure 1: Size of target and path factors for Norway and Sweden

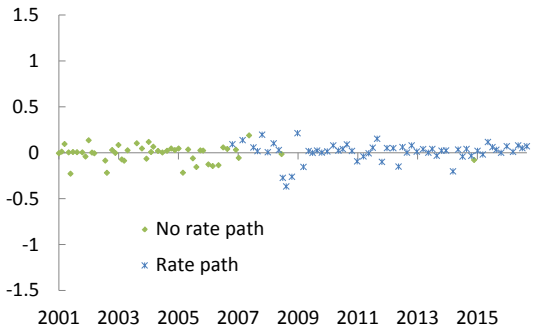
(a) Norway - target factor



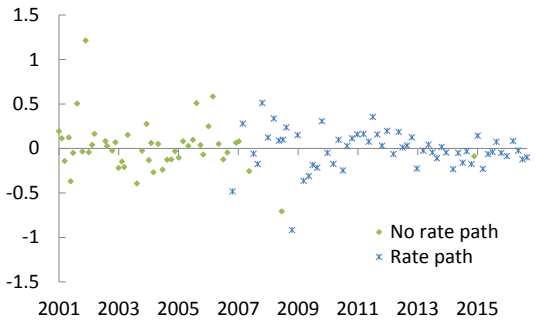
(b) Norway - path factor



(c) Sweden - target factor



(d) Sweden - path factor



Note: Figures show the size of the target and path factors for Norway and Sweden on dates where a path is published (square) or no path is published (cross).

variation in these variables. Tables 6 and 7 show the results from estimating Equation (7) with the monetary policy surprise and FRA 1 to 4 on the left hand side. We observe that both factors have a significant effect on returns on all the short term FRA-contracts. Furthermore, the results indicate that the two factors can explain most of the variation in the data, which again more or less follows by construction. In other words, these results confirm the conclusion from the rank test.

Table 6: Factor diagnostics - Norway

Norway

	Const	TarFact	adj. R2	Const	TarFact	PathFact	adj. R2
FRA 1	-0.0078	0.4538***	0.47	-0.0078***	0.4538***	0.2269***	0.90
	[0.0065]	[0.0710]		[0.0026]	[0.0473]	[0.0217]	
FRA 2	-0.009	0.4715***	0.39	-0.0090***	0.4715***	0.2929***	0.96
	[0.0082]	[0.0886]		[0.0022]	[0.0262]	[0.0141]	
FRA 3	-0.0117	0.3867***	0.27	-0.0117***	0.3867***	0.3254***	0.98
	[0.0089]	[0.0830]		[0.0016]	[0.0188]	[0.0095]	
FRA 4	-0.0153	0.3271***	0.20	-0.0153***	0.3271***	0.3271***	0.95
	[0.0093]	[0.0766]		[0.0022]	[0.0236]	[0.0170]	

Notes: This table presents diagnostics for the target and path factor for Norway. *,**,*** denote significance at 10%, 5%, and 1%, respectively. Newey-West standard errors are given in brackets.

Table 7: Factor diagnostics - Sweden

Sweden

	Const	TarFact	adj. R2	Const	TarFact	PathFact	adj. R2
FRA 1	-0.0198**	0.8136***	0.59	-0.0198***	0.8136***	0.1665***	0.75
	[0.0077]	[0.2006]		[0.0052]	[0.1643]	[0.0237]	
FRA 2	-0.0119	0.5528***	0.34	-0.0119***	0.5528***	0.2901***	0.97
	[0.0082]	[0.1165]		[0.0013]	[0.0283]	[0.0139]	
FRA 3	-0.0134	0.3850***	0.16	-0.0134***	0.3850***	0.3230***	0.97
	[0.0085]	[0.0955]		[0.0014]	[0.0461]	[0.0061]	
FRA 4	-0.0127	0.3184***	0.12	-0.0127***	0.3184***	0.3184***	0.95
	[0.0079]	[0.0951]		[0.0018]	[0.0423]	[0.0113]	

Notes: This table presents diagnostics for the target and path factor for Sweden. *,**,*** denote significance at 10%, 5%, and 1%, respectively. Newey-West standard errors are given in brackets.

Tables 8 and 9 show the results from regressing longer term yields on the target and path factors. In line with the results presented in Tables 4 and 5, the target factor significantly affects all interest rates considered, with expected signs. The effect is smaller the longer the horizons of the interest rate instruments are. The target factor has an impact on swap rates up to 10 years in both countries. Although the 10-year swap rate is affected by the target factor in Sweden, we can see that this is driven by the impact on

Table 8: Monetary policy surprises, forward guidance, and asset prices - Norway

Norway

	Const	TarFact	adj. R2	Const	TarFact	PathFact	adj. R2
2y Swap	-0.0136*	0.2498***	0.16	-0.0136***	0.2498***	0.2936***	0.95
	[0.0074]	[0.0555]		[0.0020]	[0.0180]	[0.0087]	
5y Swap	-0.0121**	0.1732***	0.13	-0.0121***	0.1732***	0.2206***	0.88
	[0.0056]	[0.0463]		[0.0020]	[0.0148]	[0.0102]	
10y Swap	-0.0116**	0.1278***	0.10	-0.0116***	0.1278***	0.1573***	0.66
	[0.0046]	[0.0431]		[0.0028]	[0.0218]	[0.0117]	
5y5y	-0.0112**	0.0823*	0.04	-0.0112***	0.0823**	0.0936***	0.24
	[0.0046]	[0.0491]		[0.0042]	[0.0400]	[0.0187]	

Notes: This table shows the results of regressing long term yields on the target and path factors for Norway based on daily windows. *,**,*** denote significance at 10%, 5%, and 1%, respectively. Newey-West standard errors are given in brackets.

Table 9: Monetary policy surprises, forward guidance, and asset prices - Sweden

Sweden

	Const	TarFact	adj. R2	Const	TarFact	PathFact	adj. R2
2y Swap	-0.0147**	0.4403***	0.30	-0.0147***	0.4403***	0.2358***	0.88
	[0.0071]	[0.1023]		[0.0026]	[0.0324]	[0.0306]	
5y Swap	-0.0119*	0.2245***	0.10	-0.0119**	0.2245***	0.1762***	0.57
	[0.0069]	[0.0690]		[0.0047]	[0.0371]	[0.0268]	
10y Swap	-0.0054	0.1204**	0.03	-0.0054	0.1204***	0.1372***	0.38
	[0.0064]	[0.0501]		[0.0047]	[0.0422]	[0.0228]	
5y5y Swap	0,0012	0.0154	-0.01	0.0012	0.0154	0.0978***	0.15
	[0.0065]	[0.0505]		[0.0056]	[0.0584]	[0.0218]	

Notes: This table shows the results of regressing long term yields on the target and path factors for Sweden, based on daily windows. *,**,*** denote significance at 10%, 5%, and 1%, respectively. Newey-West standard errors are given in brackets.

the first years of the contract, by looking at the insignificant impact on the constructed five-year in five years rate.

As the factors are uncorrelated by construction, adding the path factor does not change the coefficients on the target factor. Adding it improves the explanatory power for all the yields quite substantially. The path factor has a significant impact on yields of all maturities. The path factor becomes more important for longer interest rates. It also affects very long rates with a horizon longer than five years. Looking at returns further out on the curve, which were not part of the information set used to construct the factors, we still see that the explanatory power of the two factors is quite substantial. Even for the 10 year swap rates, the adjusted R^2 is large. This is an interesting result, as it potentially implies that the central bank's communication influences interest rate expectations for very long horizons.

As a robustness check, we have also performed a similar exercise for shorter windows (15, 45, and 90 minutes). The results are qualitatively similar, but it appears that the relative importance of the market path factor increases with windows longer than 45 minutes. This is probably not surprising, given the fact that the target factor will not change much once the decision is known, whereas the market may need more time to interpret the information from the report and press conference.

4.2.1 A 'long' path factor

In theory, monetary policy (including forward guidance) should have no effect on interest rates with maturities that exceed the stickiness of prices (Hanson and Stein, 2015, e.g.). Several papers have addressed this 'puzzle'. Gürkaynak et al. (2005a) argue that long term nominal yields are affected through long term inflation expectations. However, Nakamura and Steinsson (2013) and Hanson and Stein (2015) find that even *real* yields are affected and thus it is not (just) inflation expectations that can explain the effect. Nakamura and Steinsson (2013) argue that this is a rejection of monetary neutrality, whereas Hanson and Stein (2015) argue that monetary policy affects long term yields through its effect on term premia. Boyarchenko et al. (2016) argue that forward guidance affects risk appetite.

We can observe that the explanatory power of the combined factors decreases as the maturity of the instruments increases. Hence, one could argue that the path factor

misses out on some information further out on the interest rate curve. We have therefore performed robustness checks regarding the way we construct our factors.

Specifically, we have added interest rate instruments with longer maturities (swap rates with two- and five-year maturity) to the set of variables from which we extract factors. The results with this 'long path factor' remain qualitatively the same[15]. As expected, the impact and explanatory power of the path factor is slightly higher for the two-, five-, and 10-year swaps when we include the two- and five-year swaps in the factor extraction.

We also perform a new rank test with the full set of variables, which suggest that there might be a third factor that explains additional common variation.[16] If it is a factor that comes from the very long end of the curve, this could be measuring risk premia as Hanson and Stein (2015) and Boyarchenko et al. (2016) have suggested. However, the matrix rotation with the identifying restrictions used before is not applicable to a situation of three factors.

We therefore perform a three-step solution. First, we extract two factors from our 'narrow' set of variables: the monetary policy surprise and FRAs 1 to 4. After all, the common variation in these variables could be explained by just two factors and so we can safely extract and rotate these factors without the risk of omitting residual common variation. In the second step, we regress the longer swap rates on the target and 'short' path factor, and save the residuals. These residuals represent all the variation in the swaps that cannot be explained by the target and 'short' path factor, and thus when we extract a factor from these residuals, this factor is also orthogonal to the first two factors. Hence, we have identified the third factor without losing the interpretation of our first two factors.

Interestingly, performing a rank test on a new set of variables, that comprises the residuals of the two-, five-, and 10-year swap contracts, rejects the hypothesis that there is even one factor that can explain the common variation. However, when we add the one-year swap contract (orthogonality to the target and short path factor) to the new set of variables, we can identify one factor. This leads us to believe that the third factor explaining the common variation in the 'long' set of variables is not a term premium or long horizon risk premium, but rather a construct of the different properties of the FRA

[15]We do not report the results here due to space limitations, but they are available upon request.

[16]The evidence is mixed, though, and depends on the size of the event window and country in question.

and swap market. We restrict ourselves to the use of the target and 'short' path factor without further exploring the possibility of a third factor in the swap market.

4.2.2 Persistence

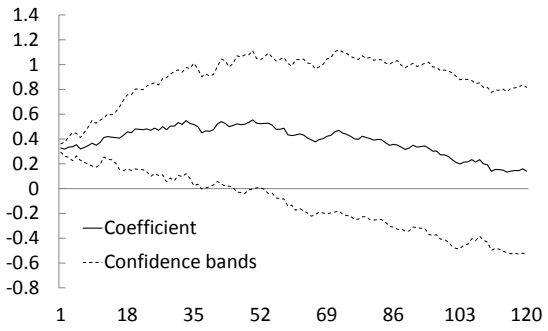
An interesting question is how persistent the effects of forward guidance on yields are. Answering this poses some obvious identification issues. Expectations on future interest rates and asset prices are constantly revised as new information comes along. Hence, one approach would be to estimate a high frequency structural VAR that could control for the systematic part of monetary policy. However, high-frequency data on inflation and activity are not readily available. Moreover, Jordà (2005) argues that using local projections minimises the effect of model misspecification. Under the assumption that the monetary policy and forward guidance 'shocks' that we have identified are exogenous and correlated with the 'true' monetary policy shock, using local projections should give us unbiased estimates of the impulse response functions of these shocks. We therefore use a simplified version of the local projections method and, in line with Swanson (2016), run regressions of the form:

$$\Delta y_{t+h} = \alpha + \beta_1 Z_{1,t} + \beta_2 Z_{2,t} + \varepsilon_{t+h} \tag{8}$$

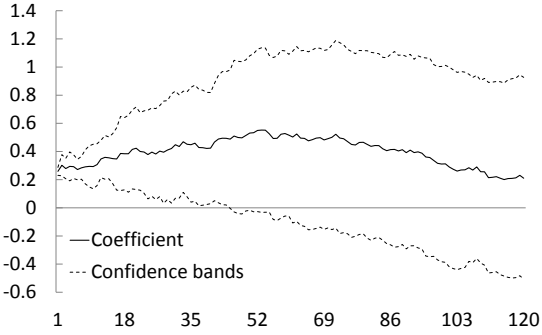
Where Δy_{t+h} is the change in asset price from close the day before the meeting until h days after. We therefore get values of β_1 and β_2 for every horizon h. We plot those values with their corresponding error bands to evaluate the persistence of monetary policy actions and communication in Figure 2 and 3. We perform the exercise for the two-, five- and 10-year swap yields as well as for the fourth FRA contract. As can be seen from the figures, the path factor appears to have a more persistent effect on yields in Sweden. For all maturities, the effect of the path factor appears to persist as long as two months out, whereas in Norway the effect is zero after around six weeks. Hence, in the case of Sweden we can say with some confidence that the effects of forward guidance is quite long-lasting. On the other hand, our approach does not permit us to conclude that the marginal effects of monetary surprises in Norway are more transitory, even though that is what the regression result seem to suggest. After all, although the lack of controls does not influence the estimate of β_2, they add noise and may thus increase the estimated standard errors.

Figure 2: Persistence of path factor for Norway

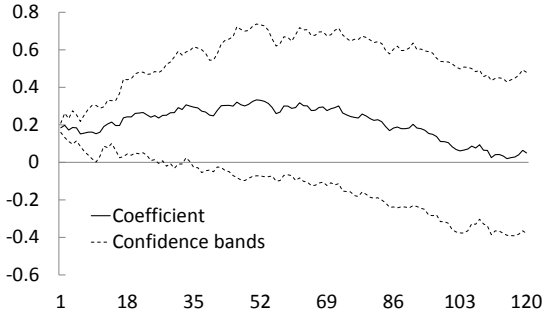
(a) Persistence effect on FRA4



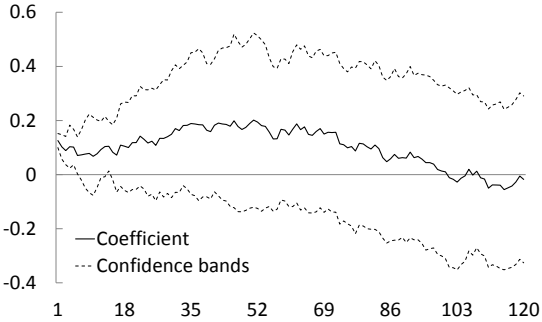
(b) Persistence effect on 2Y swap



(c) Persistence effect on 5Y swap



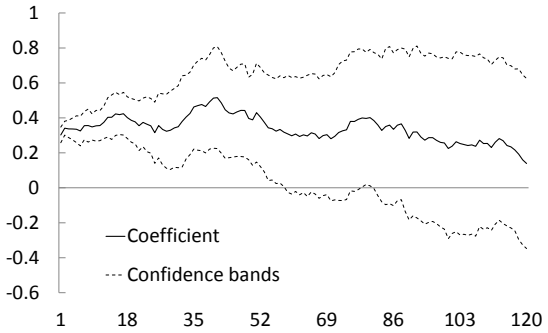
(d) Persistence effect on 10Y swap



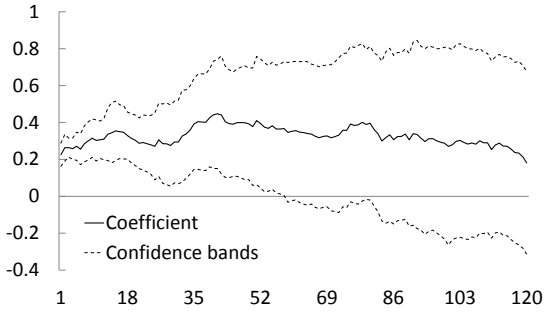
Note: These figure show the persistence of the path factor on the fourth forward rate agreement (FRA 4) and two-, five- and 10-year swap rates for Norway up to 120 days. 95% confidence bands are shown around the estimated persistence coefficients.

Figure 3: Persistence of path factor for Sweden

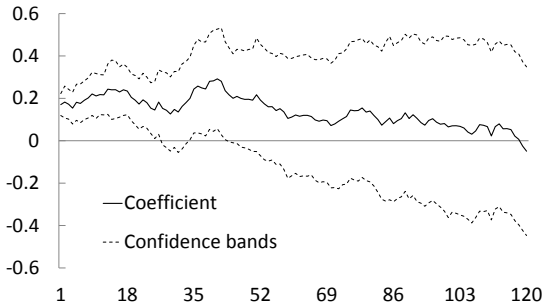
(a) Persistence effect on FRA4



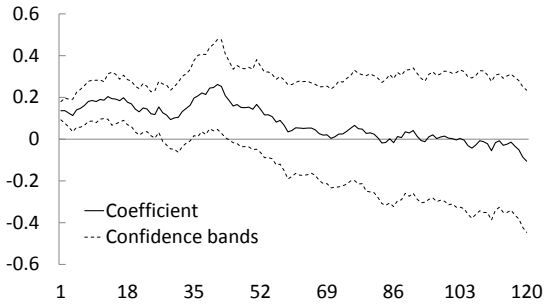
(b) Persistence effect on 2Y swap



(c) Persistence effect on 5Y swap



(d) Persistence effect on 10Y swap



Note: These figure show the persistence of the path factor on the fourth forward rate agreement (FRA 4) and two-, five- and 10-year swap rates for Sweden up to 120 days. 95% confidence bands are shown around the estimated persistence coefficients.

4.3 Forward guidance and interest rate paths

Based on the results in Section 4.2, we can conclude that the market path factor has a statistically significant and economically meaningful effect on yields along the whole yield curve. However, as discussed above, the path factor is not necessarily a good measure of forward guidance. Even if the path factor significantly moves market rates, we cannot conclude that the yields have been moved in the *intended* direction. We will therefore evaluate whether the central bank's published path moves market expectations in the direction of the path. To this end, we employ the two measures discussed in Section 2.3.

Following the last published interest rate path new information will come along that will lead both the central bank and market participants to revise their expectation of future interest rates and other variables relevant to monetary policy. To the extent that the reaction pattern of the central bank is well known to outside observers, we should expect a strong correlation between path revisions of the central bank and revisions in market expectations. We can see those correlation results in Table 10. As can be seen, the correlations are fairly strong, especially for Norway where the correlation between the market and Norges Bank's revision of the implied short term rates four quarters out is almost 0.9.[17] This is in line with findings from Bjørnland et al. (2016). These results indicate that the reaction pattern in both Norway and Sweden is understood quite well. An interesting observation is that in the case of Norway, the correlations seem to increase as we move out on the implied market curve, whereas the opposite is true for Sweden.

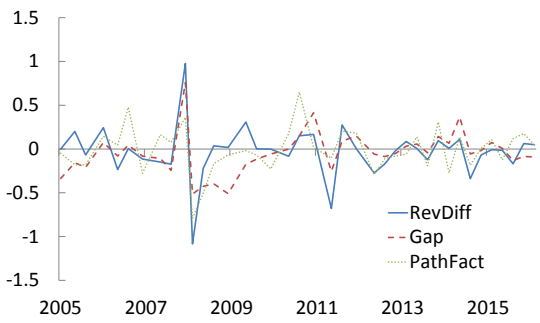
Even though the link between policy objectives and the published interest rate path might be clear, market participants expectations of key target variables such as inflation and the output gap could differ from the central bank projections. Furthermore, the information set might differ either because there exists private information not accessible to the central bank or, conversely, that the central bank possesses information not known to the market. Although there seems to be a high degree of correspondence in the assessment of new information, the processing of new information and its implication for the expected interest rate path leading up to the announcement will at times differ, even significantly, and thus there will be a potential for market surprises.

We shall now investigate to what extent these surprises feed into various yields beyond

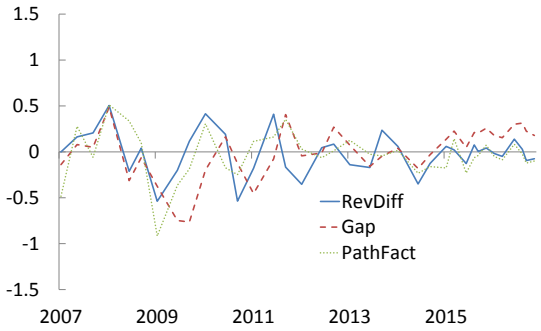
[17] Although not shown in the table, the correlations are even above 0.8 for the estimated rates eight quarters out.

Figure 4: Measures of forward guidance

(a) Norway



(b) Sweden



Note: Figures show the evolution of the market's path factor, the gap between the central bank's published path and the market's expected path, and the difference between the path revisions by the central bank and the market. These can all be seen as alternative measures of forward guidance, measured ex-ante (gap and revision) and ex-post (market's path factor).

Table 10: Correspondence of rate revisions

	Q1	Q2	Q3	Q4
Norway	0.72	0.86	0.88	0.89
Sweden	0.82	0.81	0.73	0.67

Notes: This table shows the correlation between the central bank interest rate path revisions and market revision up until the day before the new path is published.

what is explained by the current rate decision. To this end, we run regressions of the form:

$$\Delta y_{i,t} = \alpha + \beta_1 F_{1,t} + \beta_2 R^{gap}_{m,t+n} + \beta_3 path^{SURP}_{m,t+n} + \varepsilon_t \tag{9}$$

where, again, $\Delta y_{i,t}$ refers to the change in yield i, and the gap and path surprise variables are matched with the corresponding horizon of the instrument for FRA 1 to 4. For the two-year and five-year swaps we regress

$$\Delta y_{i,t} = \alpha + \beta_1 F_{1,t} + \beta_2 R^{gap}_{m,a} + \beta_3 path^{SURP}_{m,a} + \varepsilon_t \tag{10}$$

where

$$R^{gap}_{m,a} = \frac{1}{8}\sum_{n=1}^{8} R^{gap}_{m,t+n} \tag{11}$$

and

$$path^{SURP}_{m,a} = \frac{1}{8}\sum_{n=1}^{8} path^{SURP}_{m,t+n}. \tag{12}$$

Hence, when explaining the surprise in two- and five-year swaps, we summarise the gap and revision measures with their average over the first eight quarters. Ideally, we would like to match the horizon of the five-year swap as well, but our gap and path surprise variables do not span that far.

From 2007 to 2014, Sveriges Riksbank published six monetary policy documents each year, three Monetary Policy Reports (MPR) and three Monetary Policy Updates (MPU). The latter publication was, as the name would suggest, an update of the former. The Monetary Policy Update was shorter than the full-fledged report, and in some sense an interim assessment. Hence, it did not necessarily have the same status as the full report, and the forward guidance content of the two types of reports could potentially have been different. Robustness checks, available upon request, confirm that the MPRs are seen as more important. From 2015 onwards, the Riksbank has published six full reports per year.

The results are displayed in Tables 11 to 14. For Norway, we observe that both the 'revision surprise' and 'gap' matter for three-month forward rate agreements from two to four quarters out. The revision surprise also affects the market's surprise for the first FRA contract. For Sweden, the revision surprise has a significant effect for interest rate expectations up to one year. However, there is no effect from the corresponding gap

Table 11: Forward guidance and market rates - Norway

	Const	**TarFact**	**PathSurp**	**Gap**	**adj. R2**
FRA 1	-0.0077	0.5646***	0.1550**	-0.0108	0.77
	[0.0121]	[0.0891]	[0.0635]	[0.0952]	
FRA 2	-0.0075	0.4450***	0.0722*	0.0999*	0.62
	[0.0107]	[0.1172]	[0.0398]	[0.0553]	
FRA 3	-0.0058	0.2924**	0.1003***	0.1214**	0.55
	[0.0115]	[0.1207]	[0.0323]	[0.0556]	
FRA 4	-0.0073	0.1795	0.1244***	0.1348***	0.61
	[0.0098]	[0.1079]	[0.0356]	[0.0406]	

Notes: This table shows the results of regressing short term money market rates on the target factor and the gap and revision difference variables for Norway. Newey-West standard errors are given in brackets. *,**,*** denote significance at 10%, 5%, and 1%, respectively.

Table 12: Forward guidance and market rates - Sweden

	Const	**TarFact**	**PathSurp**	**Gap**	**adj. R2**
FRA 1	-0.0265***	0.7689***	0.1601**	-0.0314	0.82
	[0.0069]	[0.0823]	[0.0705]	[0.0279]	
FRA 2	-0.0243**	0.7624***	0.1260**	0.0288	0.7
	[0.0107]	[0.1272]	[0.0601]	[0.0537]	
FRA 3	-0.0263**	0.6741***	0.1002**	0.0452	0.64
	[0.0105]	[0.1423]	[0.0425]	[0.0376]	
FRA 4	-0.0218**	0.5401***	0.0882**	0.045	0.54
	[0.0106]	[0.1604]	[0.0391]	[0.0320]	

Notes: This table shows the results of regressing short term money market rates on the target factor and the gap and revision difference variables for Sweden. Newey-West standard errors are given in brackets. *,**,*** denote significance at 10%, 5%, and 1%, respectively.

Table 13: Forward guidance and yields - Norway

	Const	**TarFact**	**PathSurp**	**Gap**	**adj.R2**
2y Swap	-0.0077	0.3499*	0.0677	0.0797**	0.5
	[0.0082]	[0.1731]	[0.0447]	[0.0358]	
5y Swap	-0.0121**	0.2157**	0.0538*	0.0499**	0.48
	[0.0052]	[0.0989]	[0.0305]	[0.0224]	
10y Swap	-0.0113**	0.1525*	0.0344	0.0206	0.32
	[0.0046]	[0.0805]	[0.0232]	[0.0182]	
5y Swap 5y ahead	-0.0103**	0.0887	0.0149	-0.009	0.03
	[0.0047]	[0.0709]	[0.0223]	[0.0186]	

Notes: This table shows the results of regressing long term yields on the target factor and the gap and revision difference variables for Norway. Newey-West standard errors are given in brackets. *,**,*** denote significance at 10%, 5%, and 1%, respectively.

Table 14: Forward guidance and yields - Sweden

	Const	**TarFact**	**PathSurp**	**Gap**	**adj.R2**
2y Swap	-0.0145*	0.4974***	0.0505	0.0283*	0.41
	[0.0080]	[0.1111]	[0.0381]	[0.0154]	
5y Swap	-0.0105*	0.3045***	0.0302	0.0212*	0.31
	[0.0059]	[0.0687]	[0.0237]	[0.0113]	
10y Swap	-0.0049	0.1593***	0.0065	0.0225**	0.23
	[0.0041]	[0.0475]	[0.0107]	[0.0089]	
5y Swap 5y ahead	0.0007	0.0127	-0.0175	0.0239**	0.03
	[0.0039]	[0.0445]	[0.0155]	[0.0109]	

Notes: This table shows the results of regressing long term yields on the target factor and the gap and revision difference variables for Sweden. Newey-West standard errors are given in brackets. *,**,*** denote significance at 10%, 5%, and 1%, respectively.

measure.

Further out on the curve, only the gap seems to have a significant effect in Sweden. Interestingly, it is even somewhat informative for surprises very far out on the curve, as far as five to 10 years from now. Apparently, forward guidance matters even for 10-year yields. In Norway, the revision surprise matters for the five-year swap rates, but longer-term rates are not affected by either the gap or revision surprise.

We also note that the relative importance of the proposed measures in affecting longer term yields differ between the two countries. Whereas the 'revision difference' seems to be more important in Norway, the gap measure is the only significant measure in explaining the long end of the yield curve in Sweden.

A more direct way to assess whether there is a correlation between policy intentions and market interpretation is to regress the market path factor on the proposed metrics of forward guidance, i.e.

$$Z_{2,t} = \alpha + \beta_2 R^{gap}_{m,a} + \beta_3 path^{SURP}_{m,a} + \varepsilon_t \tag{13}$$

Hence, we ask if the latent factor explaining movements in yields is explained by our suggested measures of forward guidance. Table 15 reveals that this appears to be the case for both countries. Both measures have a significant effect on the market-derived path factor. Taken at face value, our two metrics of forward guidance can account for 47% of the total variation in Z_2 for Norway, and 19% for Sweden. Overall, this indicates that forward guidance as revealed through the published interest rate path to some degree moves the market rates in the desired direction. However, it also shows that the lion's

share of the variation in market rates around the interest rate announcement cannot be attributed to the interest rate path alone.

Table 15: Forward guidance and the path factor

	Const	**PathSurp**	**Gap**	**adj.R2**
Norway	0.0134	0.3028***	0.4401**	0.47
	[0.0286]	[0.1072]	[0.1131]	
Sweden	-0.0148	0.2276**	0.1776**	0.19
	[0.0267]	[0.1129]	[0.0709]	

Notes: This table shows the results of regressing Norway's and Sweden's path factor on the gap and revision difference variables for the corresponding countries. *,**,*** denote significance at 10%, 5%, and 1%, respectively. Newey-West standard errors are given in brackets.

5 Conclusion

In this paper we address to what extent central banks can influence market expectations by explicitly revealing future policy intentions. Based on the experience in Norway and Sweden, we conclude that to some extent they can. Surprise revisions in the policy path significantly affect the yield curve, even as far out as 10 years. Furthermore, the effects seem to persist for quite some time. However, measures that capture the surprise component in policy intentions can only explain part of what we estimate to be the underlying factor driving the main share of variations in market interest rates. One interpretation is that this factor is based on information beyond what is revealed through the published interest rate path. We point to several possible explanations, among them the fact that the interest rate path is conditional on a number of assumptions, not necessarily shared by the market participants.

Sample correlations between policy revisions and market revisions up until the interest rate announcement suggest that most of the policy revision is already internalised by market participants prior to the announcement. We take this as an indication that the monetary policy objective and the central bank reaction pattern is reasonably well understood by the market participants. However, to what extent this can be attributed to the publication of interest rate projections remains an open question.

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