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How big is the toolbox of a central banker?

Managing expectations with policy-rate forecasts: Evidence from Sweden

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Abstract

Some central banks have decided to publish forecasts of their policy rates. Can such forecasts manage market expectations of future policy rates? I use regression analysis on Swedish data to conclude that the answer is yes. The published Riksbank forecasts affect expectations of the future repo rate up to a horizon of approximately a year and a half. However, the response of market expectations to a surprise in the announced repo-rate path is not one-to-one, but is estimated to be less than half of the surprise and decreasing with the forecast horizon.

JEL classifications: E52, E58, G14.

Keywords: Policy-rate path, monetary-policy expectations.

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1 Introduction

Decisions taken at central banks affect the financial conditions for, and hence potentially the lives of, billions of people throughout the world every day. The ultimate goal of any central bank is to create stability for prices; may it be prices of commodities, currencies or something else; and the traditional means in the literature is via either the supply of money or the short-term nominal interest rate — the policy rate. However, people making financial decisions take not only the present, but also the future into account, and hence it is important to manage the expectations about the future for any successful central banker. This paper addresses one tool that might, or might not, be useful for managing such expectations.

Over the past decades, there has been a trend towards more transparency of both the decisions of central bankers and the motivating analysis behind the decisions, e.g. Dincer and Eichengreen (2007). One such step towards transparency is that a few central banks in developed countries have begun to not only announce the level of the policy rate but also the intended future development of the policy rate, a policy-rate path, beginning with the *Reserve Bank of New Zeeland* in 1997.[1] Besides providing transparency, one intention of publishing policy-rate paths is to steer the market's expectation of the future policy rate, see for example Archer (2005) and Ingves (2007). That is, if viewed as credible by the market, the policy-rate path itself constitutes a tool for the central bank in the pursuit of price stability. It is only lately that we have enough data to evaluate the potency of this tool. Can central banks use a policy-rate path to affect market expectations at all? If so; how, by how much and how far into the future?

In this paper, I use a case study with data from Sweden in an attempt to answer these and related questions. I conclude that the Swedish central bank has the ability to move market expectations of the future policy rate, as measured by forward rates, by surprising with the policy-rate path. However, the effect is not one-for-one and perhaps not present for the entire forecast horizon. These findings are qualitatively in line with the scarce existing literature on New-Zeeland data; see Moessner and Nelson (2008), Ferrero and Secchi (2009) and Detmers and Nautz (2012); and a number of tests show that they are robust.

In section 2, I discuss the econometric method used and how to match the variables of interest to available data. Section 3 presents the main results and a number of robustness tests are discussed. Finally, section 4 summarizes and concludes.

2 Method

This section describes the model used to analyse the question of interest. It also describes the data used in the estimations in detail and some assumptions that have been made, and in some cases relaxed. There is also a discussion of some potential problems with the analysis.

[1] The other central banks announcing policy-rate paths are *Norges Bank* (Norway, 2005), *Sveriges Riksbank* (Sweden, 2007) and the *Czech National Bank* (2010).

2.1 Econometric approach

In the baseline analysis, a regression approach will be used in attempt to quantify the impact of the Riksbank's announcement of a repo-rate path on the market's expectation of the future repo rate. The regression equation is

$$Impact_{h,t} = \beta_h \cdot Surprise_{h,t} + \gamma_h \cdot X_{h,t} + \varepsilon_{h,t}, \tag{1}$$

where $Impact_{h,t}$ is the movement in market expectations of the repo rate h quarters into the future at an announcement of a new repo-rate path at time t, $Surprise_{h,t}$ is the surprise component of the announced repo-rate path, $X_{h,t}$ is a vector of controls (including a horizon-specific constant) and $\varepsilon_{h,t}$ is an error term.[2] In section 2.2 I discuss how to measure these variables. The coefficient of main interest is β_h, which measures how much the market expectations are affected by (the surprise element of) the announced repo-rate path. With the correct set of control variables included in $X_{h,t}$, β_h has a causal interpretation.

An alternative specification, following Detmers and Nautz (2012), is

$$Impact_{h,t} = \beta_h^S \cdot Surprise_{h,t} + \beta_h^A \cdot Anticipated_{h,t} + \gamma_h \cdot X_{h,t} + \varepsilon_{h,t}, \tag{2}$$

where $Anticipated_{h,t}$ is the expected change (by an announcement at t) of the repo-rate path (at horizon h quarters) since the last announcement by the Riksbank. The parameter β_h^A measures the effect of an adjustment of the repo-rate path that is fully expected by the market. Without any measurement errors, in accordance with the effective-markets hypothesis, one would expect this effect to be zero. Hence, one possible interpretation is that any deviation from $\beta_h^A = 0$ can be viewed as an indication that there are measurement errors present in the variables. It is important to include the variable $Anticipated_{h,t}$ since it is difficult to measure the anticipated communication by the Riksbank, and this provides an indicator for the quality of the measure that I use. This is also in line with the findings of Kuttner (2001), although there may be other plausible interpretations as well.

It is far from obvious which is the best way to measure the three variables $Impact_{h,t}$, $Surprise_{h,t}$ and $Anticipated_{h,t}$, nor is it obvious what the relevant control variables to include in $X_{h,t}$ are. Hence, I present a number of different specifications to ensure robustness in section 2.2.

Aside from the baseline analysis, I will motivate the main question I try to answer by investigating whether expectations of the future repo rate tend to change more at days of repo-rate path announcements than other days. This will be done by a simple regression of the kind

$$|Impact_{h,t}| = \alpha_h + \delta_h \cdot D_t^{Announcement} + \eta_h \cdot D_t^{Expiration} + \varepsilon_{h,t}, \tag{3}$$

where $|Impact_{h,t}|$ is the absolute value of the movement in market expectations of the repo rate h calendar quarters into the future at day t, $D_t^{Announcement}$ is a dummy variable indicating the days on which a new repo-rate path was announced, $D_t^{Expiration}$ is a dummy variable indicating expiration dates of the contracts used to measure market expectations, and $\varepsilon_{h,t}$ is an error term. The nature of $D_t^{Expiration}$ is technical and will be explained in more detail below.

[2]Note that the coefficients in the equation are indexed by the horizon. There is one equation, and one regression, per horizon. Some control variables might be common for all horizons while others are horizon-specific.

The coefficient of interest is δ_h, which measures to what extent market expectations tend to move more, in any direction, on days of repo-rate-path announcements. If δ_h is significantly larger than zero, this is evidence that the market's expectation of horizon h is affected by the announcement.[3] If $\delta_h = 0$, this indicates one of two things; either the surprise elements of announced repo-rate paths do not impact market pricing, or the announced repo-rate paths in the sample are well in line with pre-announcement expectations.

2.2 Data

Most of the variables introduced in section 2.1 are not observed directly, hence I need to proxy them, which will result in potential measurement errors. This section will present and discuss the data used in the empirical analysis.

The Riksbank publishes a repo-rate forecast, or repo-rate path, six times per year, and has done so since the beginning of 2007. The path consists of quarterly averages for the forecast of the repo rate, and typically has a horizon of 12 quarters. It is announced together with a repo-rate decision and a monetary policy report or update, containing forecasts for a number of macroeconomic variables along with an analysis of the current economic situation.

As a measure of the market's expectations of the future repo rate, I use *Forward Rate Agreements* (FRAs) adjusted for a time-independent risk and term premium.[4] These are futures contracts on an underlying 3-month interbank rate, STIBOR.[5] [6] The usage of such contracts as a measure of market expectations of the future policy rate is in line with the existing literature, see for example Gürkaynak et al. (2007), Moessner and Nelson (2008) and Ferrero and Secchi (2009). This is also how the Riksbank measures expectations of future monetary policy in its own analysis, see Sveriges Riksbank (2013). However, there is need for caution here. It may well be that the FRAs are subject to a time-varying premium and hence do not reflect the expectations directly. There are methods to estimate such time-varying premiums, but different methods tend to give substantially different and uncertain results, so in the main analysis I keep the assumption that the premium is fixed. This assumption is relaxed in section 3.2

The FRA contracts expire two bank days prior to the third Wednesday of the last month in each quarter, i.e. approximately two weeks before the beginning of a new calendar quarter. Hence, if compensated for premia, the FRAs are good measures of the expectations of the average overnight interbank rate in a calendar quarter by the expectations hypothesis.[7] Furthermore, the overnight

[3] The announcement of a repo-rate path is not made in isolation from other announcements. More on this in section 2.2.

[4] It is important to distinguish between expected *communication* and expected *action* by the central bank. The FRAs, compensated for premia, are used as measures of the expected action, but do not provide information on which repo-rate path the market expects the Riksbank to communicate.

[5] The difference between the 3-month STIBOR and the repo rate has been rather constant and on average 0.3 percent over the period of interest. Hence, the FRA quotes are adjusted down by 0.3 percentage points in order to better reflect the expected repo rate.

[6] Also RIBA futures, similar to the FRAs but with the repo rate as the underlying rate, are traded. These are available since 2009, not for as many horizons and are traded in smaller volumes than the FRAs, and are therefore not used in the main analysis. However, using a mix of FRAs and RIBA futures doesn't change the main results much.

[7] To get an even better match with calendar quarters, I assign weights of $\frac{5}{6}$ and $\frac{1}{6}$ respectively to two consecutive FRA contracts, following Detmers and Nautz (2012). An alternative

interbank rate is very well correlated with the repo rate.

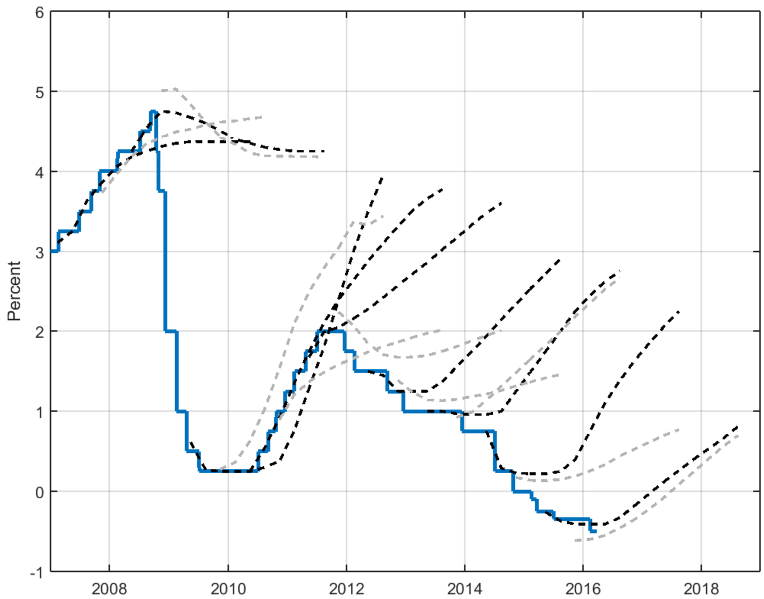

Figure 1: The evolution of the repo rate (thick blue) and selected forecasts by the Riksbank (black) and the market (grey) as quarterly averages at announcement dates. The full set of forecasts is available in figure 4 in appendix A.

Figure 1 shows the outcome of the repo rate, together with one forecast per year by the Riksbank and corresponding expectations according to the FRAs, for the period of interest.[8] Note that the Riksbank and the market have agreed during some periods and disagreed during other. There are several plausible explanations for the periods of disagreement; the information available to the market might differ from that available to the Riksbank, the premia of the FRAs might change, the view of a steady-state level of interest rate might differ, different models for the economy might be used and the Riksbank's communication might be viewed as non-credible by the market. Probably all of the above are true to some extent, and there might be other explanations too. The reasons for the historical disagreement is both important an interesting per se, but it is not the aim of this paper to explain why it has arisen. For an analysis of consequences of differences between market rates and communicated policy-rate paths, see De Graeve and Iversen (2015).

The most striking period of disagreement is perhaps in 2011, when the Riksbank projected the repo rate to continue increasing at a rapid pace while the market expected the repo rate to increase at a much slower pace or even de-

would be to use the method suggested by Nelson and Siegel (1987) or the extended version in Svensson (1994).

[8]When all forecasts are included the figure becomes difficult to comprehend, see figure 4 in appendix A.

crease. As can be seen in the figure, the market turned out to be less wrong ex-post. This example is discussed in more detail in Svensson (2015).

The FRA quotes are observed for horizons 1 to 12 quarters. More formally, we have the following relationship between the FRAs and the expected future repo rate,

$$FRA_{h,t} = \mathrm{E}_t\left[i^{repo}_{t+h}\right] + \zeta_{h,t}, \tag{4}$$

where $FRA_{h,t}$ is the observed futures rate for horizon h just after the announcement at time t, $\mathrm{E}_t\left[i^{repo}_{t+h}\right]$ is the market's expectation of the repo rate h calendar quarters from t and $\zeta_{h,t}$ is the premium for horizon h at time t.[9] Under the assumption that the premium is not affected by the announcement, i.e. $\zeta_{h,t} = \zeta_{h,t-\epsilon}$ for all $h \in \{1, 2, \cdots, 12\}$, it is straightforward to define the data version of the dependent variable as

$$\begin{aligned} Impact_{h,t} &= FRA_{h,t} - FRA_{h,t-\epsilon} \\ &= \mathrm{E}_t\left[i^{repo}_{t+h}\right] - \mathrm{E}_{t-\epsilon}\left[i^{repo}_{t+h}\right], \end{aligned} \tag{5}$$

where $t - \epsilon$ refers to just prior to the announcement. The assumption that the premium is unaffected by the announcement is possibly strong, but difficult to overcome. If this assumption is too strong, $Impact_{h,t}$ cannot be interpreted as being to the market expectation but rather to the market rates, which are also important for a central bank to manage.

What is meant by "just after" and "just prior to" an announcement? Is the difference one day, hour, minute, second or something else? In this study I use end-of-day quotes, so ϵ corresponds to one day. This is common in the literature, see e.g. Ehrmann and Fratzscher (2004) and Moessner and Nelson (2008), and has the advantage that the market has time to fully incorporate the new information announced by the Riksbank in the prices used. A drawback is, however, that the prices will also be influenced by other news and information arriving within the same day. An alternative would be to use intra-day quotes, which is done by Gürkaynak et al. (2005) and advocated by Winkelmann (2010). Choosing this approach instead does not seem to affect the results much.[10] In section 3.2 I also apply a method aimed at controlling for other news arriving within the same days.

I now turn to the variable $Anticipated_{h,t}$ in equation (2). This variable is the market's expected change in the repo-rate path between two consecutive Riksbank announcements. Another way of putting it is that the repo-rate path that the market expects the Riksbank to announce, just prior to the announcement, is the sum of the last published repo-rate path and the variable $Anticipated_{h,t}$. The idea is that the market uses all available information; that which was previously announced by the Riksbank and the new information that has arrived since the last announcement.[11] Some alternative views on this variable are discussed in section 3.2.

[9] Björk (2004) shows that even in a risk neutral setting, the expectations hypothesis need not hold. However, most central banks, including the Riksbank, rely on the expectations hypothesis adjusted for premia in this type of analysis, so I follow their example.

[10] I don't have access to intra-day quotes for the entire period of interest or all horizons, but combining daily data with what intra-day data I have results in only minor changes to the results.

[11] This is similar to what Archer (2005) does. Winkelmann (2010) takes another approach, using jumps in medium- to long-term rates on announcement days to identify anticipated and unanticipated surprises in the announced path.

In the baseline case, I will assume that the market expects the Riksbank to update its view on the repo-rate path in the same way that the market itself updated its view since the last announcement. In this case, I define

$$Anticipated_{h,t} = FRA_{h,t-\epsilon} - FRA_{h,t_p}, \tag{6}$$

where $FRA_{h,t-\epsilon}$ is the futures rate of horizon h just prior to the announcement at time t, as before, and FRA_{h,t_p} is the futures rate just after the previous announcement by the Riksbank.[12] One implication of this definition is that I assume that the market expects any discrepancy between the market's expectation and the forecast in the Riksbank's last announced path to remain unchanged in the coming announcement, given time-fixed premia.

With this definition of the anticipated change of the repo-rate path, the surprise, or unanticipated change, is defined as the difference between the actual and the anticipated change;

$$Surprise_{h,t} = \left(Path^{RB}_{h,t} - Path^{RB}_{h,t_p}\right) - Anticipated_{h,t}, \tag{7}$$

where $Path^{RB}_{h,t}$ is the repo-rate path for horizon h, announced by the Riksbank at time t and $Path^{RB}_{h,t_p}$ is the previously announced path.

As noted above, defining $Anticipated_{h,t}$ and $Surprise_{h,t}$ by equations (6) and (7) assumes that the market expects the Riksbank to update its views in the same way that the market has updated its views. This need of course not be the case. Alternatively, the anticipated and unanticipated changes in the repo-rate path can be defined as the explained parts and residuals respectively of the following regressions:

$$Path^{RB}_{h,t} = \alpha_h + \mu^M_h \cdot FRA_{h,t-\epsilon} + \mu^{M_p}_h \cdot FRA_{h,t_p} + \mu^P_h \cdot Path^{RB}_{h,t_p} + Surprise_{h,t}. \tag{8}$$

After running these regressions, it is natural to define the anticipated change in the repo-rate path since the last announcement as

$$Anticipated_{h,t} = \alpha_h + \mu^M_h \cdot FRA_{h,t-\epsilon} + \mu^{M_p}_h \cdot FRA_{h,t_p} + \left(\mu^P_h - 1\right) \cdot Path^{RB}_{h,t_p}. \tag{9}$$

The explained part of the right-hand side of equation (8) contains the level, and change since last announcement, of the market rates as well as the previously announced path by the Riksbank. This way of defining the anticipated changes and surprises through regression is similar to what Moessner and Nelson (2008) suggest and to what Ferrero and Secchi (2009) do. Note that the simpler definition in equation (6) corresponds to the case $\alpha_h = 0$, $\mu^M_h = \mu^P_h = 1$ and $\mu^{M_p}_h = -1$ in equation (9).

Regardless of whether $Anticipated_{h,t}$ and $Surprise_{h,t}$ are defined by equations (6) and (7) or equations (8) and (9), there is an obvious risk of correlation between the two. My variable of interest is $Surprise_{h,t}$, so if $Anticipated_{h,t}$ is also correlated with the dependent variable $Impact_{h,t}$, it should be included in

[12] The Riksbank publishes a new repo-rate path six times per year, so on average the previous announcement was made two months earlier. However, the intervals between meetings differ over the year.

the right-hand side in the main analysis to avoid omitted-variable bias. I.e., if that is the case, I should use equation (2) rather than (1).

As should be clear from above, the measure of $Surprise_{h,t}$ is uncertain and may well contain measurement errors. If that is the case, the regression equations (1) and (2) will suffer from regression dilution, also known as attenuation bias, and the estimates of β_h and β_h^S will be biased towards zero. I.e., the true coefficients may in fact be at a greater distance from zero than the results in section 3.1 suggest.

Next I turn to the potential vector of control variables, $X_{h,t}$ in equations (1) and (2). There might be two reasons to include control variables. The first, and most important, reason would be to prevent omitted-variables bias. It is known, see for example Angrist and Pischke (2008), that leaving out any independent variable that is correlated with the dependent variable and the independent variable of interest will bias the coefficient of interest. The direction of the bias depends on the correlations in question and is in general not known. Hence, I include independent variables that I suspect can have explanatory value for both the $Surprise_{h,t}$ and $Impact_{h,t}$ variables. The second reason to include more independent variables is that there might be variables that are not correlated with the surprise, but when interacted with it explains the impact. As mentioned above, including more independent variables comes at a cost of lower power of the results.

Section 3 presents results with different specifications of the control vector. The following variables are included mainly to prevent omitted-variables bias:

Surprise in decision: A measure of the surprise in the repo-rate decision.[13] One can suspect that this very well correlates with surprises along the repo-rate path. Details on how this measure is constructed is found in appendix B.

Surprise in other horizons: The average surprise for all horizons *except* the one the regression concerns.[14] If the market pays no attention to the time precision of the repo-rate path, and only reacts to movements in the entire path for all horizons, it will be captured by this term rather than in β_h or β_h^S.

Dummy, effective lower bound: The Riksbank has, at some occasions, communicated that lowering the repo rate further might result in technical difficulties due to an effective lower bound. Such a lower bound might affect both the communication by the Riksbank and the interpretation by the market.[15]

Disagreement: As can be seen in figure 4, there have been periods when the level of disagreement between the Riksbank's forecasts and the market's

[13] A similar control variable is also used in Ferrero and Secchi (2009), although constructed slightly differently. None of the other covariates listed here seem to be present in the literature addressing this question.

[14] Since two consecutive announcements are often made in two different quarters, the repo-rate path from the previous announcement only covers the 11 first quarters of the new announced path. There are not enough data points where this is not the case to analyse the surprise in the 12 quarter horizon. Hence, this control variable is the average surprise in horizon 1–11 quarters, except the horizon that the regression concerns h.

[15] The communication whether the interest rate is on the effective lower bound, or close enough to affect the monetary policy, is not always clear. I regard a lower bound to be effective for the period July 2009 – April 2010 and July 2014 – July 2015.

expectations has been both high (with positive and negative sign) and low. It might be that the level of disagreement affects the reasoning by the Riksbank as well as the market's reaction to Riksbank communication. I therefore include a backward-looking one-year moving average of the disagreement (average for all horizons) between the Riksbank's forecast and the market pricing, at the time of the last announcement. This proxy measure of disagreement is demeaned.

As mentioned above, an announcement by the Riksbank contains more than just a repo-rate decision and path. Aside from the list presented above, it would be desirable to also include controls for the market surprise in the remaining parts of the announcement, i.e. forecasts for other macroeconomic variables and analysis of the current economic situation. However, it is very difficult to find such measures.

The following independent variables are included mainly because I am interested in the interaction effect with the surprise:

Dummy, surprise decreases disagreement: Along the line of thought that the level of agreement between the Riksbank forecast and market expectations might affect the impact on market expectations, I include a dummy for whether the surprise works to increase or decrease the disagreement. A surprise that decreases the disagreement might be viewed as more credible by the market than a surprise that increases the disagreement further. When included, the dummy variable is demeaned and interacted with the surprise.

Announcement timing: The monetary policy meetings of the Riksbank are held at different times within the quarter. Consequently, at some meetings the one quarter ahead forecast refers to a quarter beginning only a few days later, while at other meetings the one quarter ahead forecast refers to a quarter beginning almost three months from the meeting. A reasonable hypothesis is that a repo-rate path announced closer to the beginning of a new quarter will be viewed as more credible and hence a surprise in such a meeting could have a larger impact on market expectations, particularly for short horizons. To capture this, the fraction of the quarter still remaining is included as a control, demeaned and interacted with the surprise.

Using the full set of control variables, equation (2) can be written as

$$\begin{aligned} Impact_{h,t} = \beta_h^S \cdot Surprise_{h,t} + \beta_h^A \cdot Anticipated_{h,t} + \gamma_{0,h} + \gamma_{1,h} \cdot Surprise_{0,t} \\ + \gamma_{2,h} \cdot \frac{1}{10} \sum_{j \neq h} Surprise_{j,t} + \gamma_{3,h} \cdot D_t^{ELB} + \gamma_{4,h} \cdot \widetilde{Disagreement}_t + \\ \gamma_{5,h} \cdot \widetilde{D}_{h,t}^{Closing} \cdot Surprise_{h,t} + \gamma_{6,h} \cdot \widetilde{Fraction}_t \cdot Surprise_{h,t} + \varepsilon_{h,t}, \end{aligned} \tag{10}$$

where $\tilde{}$ denotes deviation from mean (for that specific horizon). Note that under this specification the effect of $Surprise_{h,t}$ on $Impact_{h,t}$ is not captured entirely by β_h^S, but rather we have

$$\frac{\partial Impact_{h,t}}{\partial Surprise_{h,t}} = \beta_h^S + \gamma_{5,h} \cdot \widetilde{D}_{h,t}^{Closing} + \gamma_{6,h} \cdot \widetilde{Fraction}_t. \tag{11}$$

Table 1: Regression results of equation (3)

$h =$	1	2	3	4	5	6	7	8	9	10	11	12
α_h	0.02***	0.02***	0.03***	0.03***	0.04***	0.04***	0.04***	0.04***	0.03***	0.04***	0.04***	0.03***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
δ_h	0.07***	0.05***	0.05***	0.04***	0.03***	0.02***	0.02***	0.01**	0.02***	0.02***	0.02***	0.02***
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
η_h	0.18***	0.14***	0.09***	0.10***	0.09***	0.08***	0.07***	0.06***	0.05***	0.04***	0.03***	0.02***
	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
R^2	0.25	0.16	0.10	0.10	0.06	0.06	0.02	0.01	0.03	0.01	0.01	0.01
p_F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Obs.	2604	2604	2604	2597	2600	2604	2597	2604	2604	2604	2604	2598

Equation: $|Impact_{h,t}| = \alpha_h + \delta_h \cdot D_t^{Announcement} + \eta_h \cdot D_t^{Expiration} + \varepsilon_{h,t}$.
Data sources: Bloomberg, Nasdaq OMX and the Riksbank.
Note: h refers to the horizon in quarters. ***, ** and * refer to significance at the 1%, 5% and 10% levels respectively.

In other words, β_h^S is a good approximation of the effect of $Surprise_{h,t}$ on $Impact_{h,t}$ if the remaining two terms in (11) are well approximated by zero, either due to the coefficient being small, the independent variables being small or both. In general, more than just the estimates of β_h^S must be considered. This will be discussed further in section 3.1, where the results are presented.

3 Results

Before turning to the main analysis, I will briefly motivate why it is worth digging into the question of interest. Table 1 reports the regression results of equation (3), where I have used end-of-day FRA quotes for all trading days between February 2005 and July 2015.[16] Note that one regression is run per horizon h. The coefficient of interest is δ_h, which is interpreted as the extra movement of FRA quotes on days when a new repo-rate path is announced, in total 49 days in the sample. We note that δ_h is significantly larger than zero for all horizons, indicating that repo-rate expectations tend to move more on announcement days than non-announcement days, still under the assumption that the premium is approximately unaffected by the announcement. Comparing the size of δ_h with the size of α_h, which captures the average movement of the FRA quote on non-announcement trading days, we see that the effect is not only statistically significant but also economically very significant, especially for shorter horizons.
The variable $D_t^{Expiration}$ in equation (3) is a dummy for the expiration dates, i.e. dates when a FRA contract switches from referring to one calendar quarter to the next. This must of course be taken into consideration. The interpretation of η_h is hence the average difference of the FRA price between two consecutive

[16] The standard errors reported in regression tables throughout the paper are heteroscedasticity-consistent, see e.g. Angrist and Pischke (2008).

Table 2: Regression results of equation (1)

$h =$	1	2	3	4	5	6	7	8	9	10	11
β_h	0.55***	0.25**	0.14**	0.10**	0.08**	0.06*	0.06*	0.03	0.01	−0.00	−0.01
	(0.16)	(0.11)	(0.07)	(0.05)	(0.04)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)
$\gamma_{0,h}$	0.01	0.00	−0.01	−0.01	−0.01	−0.00	−0.01	−0.01	−0.01	−0.00	0.01
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
R^2	0.53	0.16	0.13	0.13	0.13	0.11	0.09	0.03	0.01	0.00	0.00
p_F	0.00	0.01	0.01	0.01	0.01	0.02	0.05	0.24	0.56	0.98	0.68
Obs.	41	46	47	48	48	47	46	46	46	47	40

Equation: $Impact_{h,t} = \beta_h \cdot Surprise_{h,t} + \gamma_{0,h} + \varepsilon_{h,t}$.
Data sources: Bloomberg, Nasdaq OMX and the Riksbank.
Note: h refers to the horizon in quarters. In this regression, the control vector, $X_{h,t}$, consists of a vector of ones only. ***, ** and * refer to significance at the 1%, 5% and 10% levels respectively.

horizon quarters, at the expiration dates. This might capture both premia and expectations of future short rates. There are in total 42 expiration days in the sample.

The overall conclusion from this introductory analysis is that it is worthwhile investigating the movements of the FRA quotes on announcement days closer. That is the main purpose of this paper, and will be presented in the following sections.

3.1 Main results

I begin by investigating the very simplest case, and thereafter add complexity in steps. The very simplest case is to run the regressions, one per horizon, in equation (1) without any control variables, i.e. $X_{h,t}$ is only a vector of ones so that γ_h is an intercept. I also use the simpler definition of $Surprise_{h,t}$, i.e. it is defined by equations (6) and (7). The result of these regressions are presented in table 2.

The estimates of β_h suggest that a surprise in the repo-rate path announced by the Riksbank might have a significant effect on market expectations up to a horizon of about 5–7 quarters. However, the suggested effect is quite small for horizons beyond 1 or perhaps 2 quarters.[17] Note in table 2 that the coefficient of determination, R^2, is low for horizons beyond 1 quarter, suggesting that this model does not perform well in explaining how market expectations are updated on announcement days.

The results of these first simple regressions suggest that the effect we are looking for, the ability of the Riksbank to affect market expectations with the repo-rate path, is present. However, the results should be viewed with great caution. There are reasons to believe that the estimates of β_h are biased, partly

[17] The interpretation of, for instance, $\hat{\beta}_1 = 0.55$ is that a surprise of 100 basis points in the repo-rate path one quarter ahead should move the market expectations 55 basis points in the same direction for that horizon. Although the estimate for $\hat{\beta}_7 = 0.06$ is perhaps significantly larger than zero, a movement of market expectations of 6 basis points in response to a 100 basis point surprise must be regarded as very close to nothing.

Table 3: Regression results of equation (2)

$h =$	1	2	3	4	5	6	7	8	9	10	11
β_h^S	0.47***	0.32***	0.22***	0.18***	0.14***	0.13***	0.13***	0.12***	0.09**	0.06*	0.05
	(0.09)	(0.08)	(0.07)	(0.05)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)
β_h^A	0.22***	0.13***	0.11**	0.12***	0.11***	0.12***	0.11***	0.11***	0.09***	0.07*	0.07
	(0.06)	(0.04)	(0.05)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.05)
$\gamma_{0,h}$	0.02*	0.02	0.01	0.01	0.01	0.02**	0.01	0.01	0.01	0.01	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
R^2	0.72	0.31	0.28	0.35	0.38	0.43	0.39	0.31	0.21	0.09	0.08
p_F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.13	0.22
Obs.	41	46	47	48	48	47	46	46	46	47	40

Equation: $Impact_{h,t} = \beta_h^S \cdot Surprise_{h,t} + \beta_h^A \cdot Anticipated_{h,t} + \gamma_{0,h} + \varepsilon_{h,t}$.
Data sources: Bloomberg, Nasdaq OMX and the Riksbank.
Note: h refers to the horizon in quarters. In this regression, the control vector, $X_{h,t}$, consists of a vector of ones only. ***, ** and * refer to significance at the 1%, 5% and 10% levels respectively.

since we may have a bad measure of the surprise parts of the announced repo-rate paths, partly because there might be other explanatory variables that are correlated with both the impact on expectations and the surprise part of the repo-rate paths. I will now try to remedy these potential problems.

In the next step, I add also the anticipated change in the repo-rate path to the analysis. This should give a hint on the quality of our measure of the surprise part of the announced paths. Table 3 shows the results of the regressions in equation (2), still using equations (6) and (7) to define the anticipated change and the surprise. Note that this leads to a substantial increase in the R^2, and for most horizons also in the estimates of the coefficient for the surprise, $\hat{\beta}_h^S$, compared to the case where the anticipated change is not included. This is a symptom that omitted-variables bias was present but has now been partly overcome. The significant effect of the surprise now stretches up to a 9-to-10-quarter horizon. However, also note that the estimates of the coefficient for the anticipated change, β_h^A, are significantly larger than zero for most horizons. As discussed in section 2.1, this might be an indication that the measure of the variable $Anticipated_{h,t}$ is bad, and consequently also the measure of $Surprise_{h,t}$.

Given the potential problem identified above, the next natural step is to try to improve the measure of $Anticipated_{h,t}$ from the definition in equation (6). As described in section 2.1, one method, closely related to that suggested in Ferrero and Secchi (2009), is to define $Anticipated_{h,t}$ by equation (9) after running the regressions of equation (8). Note also that $Surprise_{h,t}$ is then defined as the unexplained part, or residual, of the same regression. Denoting the regression in (8) by *first stage* and the regression in (2) by *second stage*, the results are presented in table 4.

Let us first consider the first stage. Recall that with $\alpha_h = 0$, $\mu_h^M = \mu_h^P = 1$ and $\mu_h^{M_p} = -1$, equations (6) and (9) are equivalent. It is apparent from table 4 that this is a bad assumptions for all horizons beyond one quarter. Further,

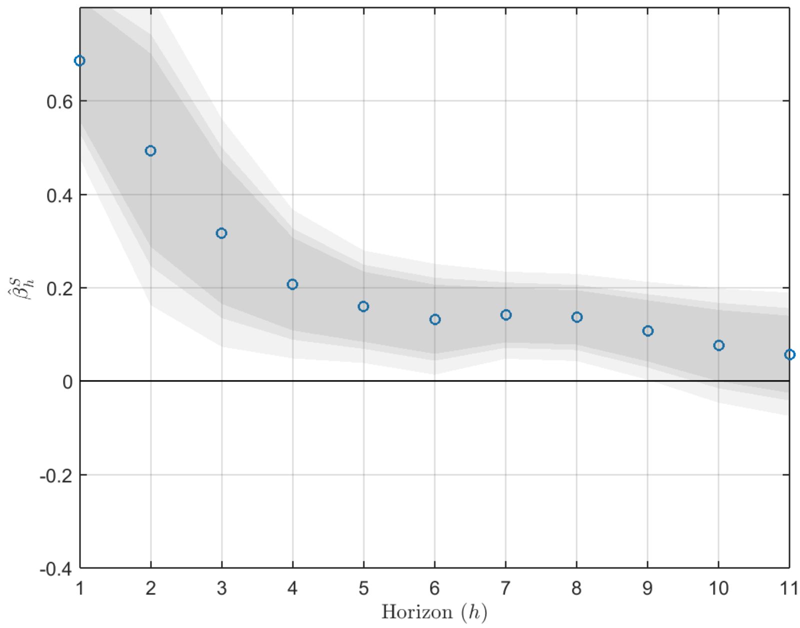

Figure 2: Estimates of β_h^S in equation (2), with 90%, 95% and 99% confidence intervals, for different horizons in quarters.

note that R^2 is high, indicating that the regressions of equation (8) captures the determination of $Anticipated_{h,t}$ quite well.

The second stage is presented in table 4 and in figure 2, where the estimates of β_h^S are illustrated with confidence intervals for each horizon h. The estimates of β_h^A are not as significantly different than zero as compared to table 3.[18] This also strengthens the hypothesis that equations (8) and (9) is a good model for the variable $Anticipated_{h,t}$. Note also that for some quarters, the estimated impact of the surprise, $\hat{\beta}_h^S$, increases substantially. Also the R^2 increases for some horizons, indicating that the regressions presented in table 4 fits better than those in table 3.

The results presented in table 4 and figure 2 may be viewed as the main results of this study. However, as mentioned above, there are still reasons to suspect bias in $\hat{\beta}_h^S$ due to omitted variables and regression dilution. I also run the regressions including all the control variables discussed in detail in section 2.2, i.e. run the regression in equation (10), in an attempt to decrease the omitted-variables bias. The full results are shown in table 5, and the estimates of β_h^S are illustrated in relation to the horizon h in figure 3. Note that the variables $Anticipated_{h,t}$ and $Surprise_{h,t}$ are still defined by the first-stage regressions of equation (8). However, nothing is changed in the first-stage regression from table 4, so table 5 only shows the second stage.

First note that the R^2 values increase for all horizon, and for some quite

[18] In fact, leaving $Anticipated_{h,t}$ out of the second-stage equation doesn't change the results by much.

Table 4: Regression results of equations (2) and (8)

$h =$	1	2	3	4	5	6	7	8	9	10	11
						Second stage					
β_h^S	0.69***	0.49***	0.32***	0.21***	0.16***	0.13***	0.14***	0.14***	0.11***	0.08	0.06
	(0.08)	(0.12)	(0.09)	(0.06)	(0.04)	(0.04)	(0.03)	(0.03)	(0.04)	(0.05)	(0.05)
β_h^A	0.19***	0.07	0.04	0.05	0.05	0.06*	0.06*	0.06*	0.06	0.06	0.01
	(0.04)	(0.04)	(0.05)	(0.04)	(0.03)	(0.04)	(0.03)	(0.03)	(0.04)	(0.05)	(0.05)
$\gamma_{0,h}$	−0.01	0.01	−0.00	−0.01	−0.01	−0.01	−0.01	−0.00	−0.00	0.01	−0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
R^2	0.82	0.41	0.37	0.36	0.37	0.34	0.36	0.33	0.21	0.09	0.04
p_F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.14	0.44
Obs.	36	46	46	48	48	48	46	46	46	46	48
						First stage					
α_h	−0.00	−0.01	−0.03	−0.07	−0.06	−0.04	0.05	0.09	0.11	0.09	0.08
	(0.03)	(0.03)	(0.04)	(0.05)	(0.07)	(0.08)	(0.09)	(0.10)	(0.13)	(0.15)	(0.15)
μ_h^M	1.12	0.92	0.82**	0.74***	0.68***	0.59***	0.59***	0.51***	0.45***	0.38***	0.35***
	(0.10)	(0.06)	(0.07)	(0.09)	(0.10)	(0.11)	(0.10)	(0.09)	(0.08)	(0.08)	(0.07)
$\mu_h^{M_p}$	−0.90	−0.58***	−0.46***	−0.45***	−0.43***	−0.34***	−0.32***	−0.26***	−0.22***	−0.17***	−0.16***
	(0.21)	(0.14)	(0.13)	(0.13)	(0.12)	(0.11)	(0.11)	(0.11)	(0.11)	(0.10)	(0.09)
μ_h^P	0.75	0.66**	0.66***	0.74**	0.78**	0.77***	0.73***	0.74***	0.76**	0.78**	0.81**
	(0.19)	(0.15)	(0.12)	(0.10)	(0.08)	(0.07)	(0.08)	(0.08)	(0.09)	(0.09)	(0.08)
R^2	0.99	0.99	0.98	0.97	0.96	0.94	0.95	0.95	0.95	0.95	0.95
Obs.	36	46	46	48	48	48	46	46	46	46	48

First stage: $Path_{h,t}^{RB} = \alpha_h + \mu_h^M \cdot FRA_{h,t-\epsilon} + \mu_h^{M_p} \cdot FRA_{h,t_p} + \mu_h^P \cdot Path_{h,t_p}^{RB} + Surprise_{h,t}$.
Second stage: $Impact_{h,t} = \beta_h^S \cdot Surprise_{h,t} + \beta_h^A \cdot Anticipated_{h,t} + \gamma_{0,h} + \varepsilon_{h,t}$.
Data sources: Bloomberg, Nasdaq OMX and the Riksbank.
Note: h refers to the horizon in quarters. In the first-stage regression, significance levels refer to significant difference from the reference levels $(0, 1, -1, 1)$ for $(\alpha_h, \mu_h^M, \mu_h^{M_p}, \mu_h^P)$ respectively. In the second-stage regression, the control vector, $X_{h,t}$, consists of a vector of ones only. ***, ** and * refer to significance at the 1%, 5% and 10% levels respectively.

much, compared to the case where the control variables are not included (4). This suggests that the controls included are helpful in explaining the impact on market expectations, as measured by the FRA contracts. In other words, the model where the controls are included is probably closer to the true model explaining the impact on the FRA quotes than the one without controls. This indicates that I might have overcome some omitted-variables bias.

Now turn to the estimates of β_h^S. We see that these decrease for short horizons as well as long horizons when the controls are included. However, they increase for some medium-term horizons. The most likely explanation to why

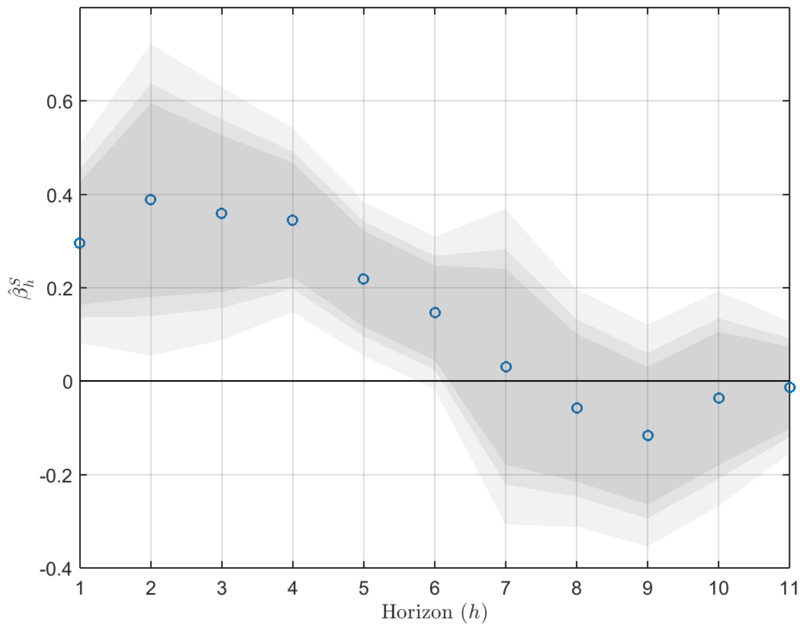

Figure 3: Estimates of β_h^S in equation (10), with 90%, 95% and 99% confidence intervals, for different horizons in quarters.

the estimates decrease for short horizons is that these are affected by the control for the surprise in the repo-rate decision. The estimates of these coefficients, $\gamma_{1,h}$, are significantly larger than zero for horizons of 1 and 2 quarters. Judging from the size of the estimates, it seems that a surprise in the repo-rate decision is more effective than a surprise to the repo-rate path at managing the market expectations of very short horizons.

There are some more notable results in table 5. The standard errors of $\hat{\beta}_h^S$ increase compared to the case where the control variables are not included. This is probably the effect of small samples being used to estimate more parameters. As in the case without control variables, the estimates of β_h^A are well approximated by zero for most horizons, and the main results remain if $Anticipated_{h,t}$ is left out of the equation.

The estimates of $\gamma_{2,h}$, capturing the impact on forward rates for horizon h from path surprises in all horizons except h, are significantly different than zero for some horizons. This suggests that that there may be reactions to the entire curve rather than the specific quarterly timing of the repo-rate path. Some of the $\hat{\beta}_h^S$ might be overestimated in the sense that there is a counter impact in the other direction, while other might be underestimated. However, for most horizons the estimates of $\gamma_{2,h}$ are well approximated by zero, so the main picture remains intact.

The two terms containing the coefficients $\gamma_{3,h}$ and $\gamma_{4,h}$ are included, as was mentioned above, in attempt to prevent omitted-variables bias. Although the estimates of these might be interesting for other reasons, they are not important

Table 5: Regression results of equation (10)

$h =$	1	2	3	4	5	6	7	8	9	10	11
						Second stage					
β_h^S	0.30***	0.39***	0.36***	0.34***	0.22***	0.15**	0.03	−0.06	−0.12	−0.04	−0.01
	(0.08)	(0.12)	(0.10)	(0.07)	(0.06)	(0.06)	(0.12)	(0.09)	(0.09)	(0.08)	(0.05)
β_h^A	0.08***	−0.00	0.02	0.01	0.00	0.00	0.03	0.06*	0.05	0.04	0.06
	(0.03)	(0.05)	(0.05)	(0.04)	(0.03)	(0.04)	(0.03)	(0.04)	(0.04)	(0.06)	(0.06)
$\gamma_{0,h}$	−0.00	0.02*	0.02*	0.02**	0.02*	0.01	0.02	0.01	0.01	0.02	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$\gamma_{1,h}$	0.64***	0.50***	0.23	0.22*	0.19*	0.17	0.03	−0.01	−0.04	−0.01	0.02
	(0.12)	(0.18)	(0.19)	(0.13)	(0.10)	(0.11)	(0.14)	(0.15)	(0.12)	(0.14)	(0.11)
$\gamma_{2,h}$	0.01	−0.03	−0.07	−0.20**	−0.13	−0.07	0.12	0.24*	0.27**	0.07	0.11*
	(0.05)	(0.09)	(0.09)	(0.09)	(0.10)	(0.12)	(0.19)	(0.14)	(0.11)	(0.11)	(0.05)
$\gamma_{3,h}$	−0.01	−0.06***	−0.07***	−0.09***	−0.06***	−0.04***	−0.04**	−0.02	−0.02	0.00	−0.02
	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)
$\gamma_{4,h}$	−0.01	0.02	0.06	0.05	0.04	0.02	0.01	−0.02	−0.02	−0.03	−0.04
	(0.03)	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)
$\gamma_{5,h}$	0.02	0.03	0.17	0.25***	0.18***	0.19***	0.22***	0.10	0.18**	0.28	−0.07
	(0.09)	(0.14)	(0.13)	(0.09)	(0.06)	(0.07)	(0.08)	(0.08)	(0.09)	(0.18)	(0.12)
$\gamma_{6,h}$	−0.70***	−1.13**	−0.74***	−0.46***	−0.33***	−0.28**	−0.18	−0.10	0.02	0.10	−0.03
	(0.18)	(0.44)	(0.25)	(0.13)	(0.10)	(0.11)	(0.14)	(0.14)	(0.14)	(0.20)	(0.20)
R^2	0.92	0.68	0.60	0.68	0.68	0.63	0.50	0.41	0.38	0.20	0.17
p_F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.33	0.47
Obs.	36	46	46	48	48	48	46	46	46	46	48

Equation: $Imp_{h,t} = \beta_h^S \cdot Surp_{h,t} + \beta_h^A \cdot Antic_{h,t} + \gamma_{0,h} + \gamma_{1,h} \cdot Surp_{0,t} + \gamma_{2,h} \cdot \frac{1}{10} \sum_{j \neq h} Surp_{j,t} + \gamma_{3,h} \cdot D_t^{ELB} + \gamma_{4,h} \cdot \widetilde{Disagr}_t + \gamma_{5,h} \cdot \widetilde{D}_{h,t}^{Closing} \cdot Surp_{h,t} + \gamma_{6,h} \cdot \widetilde{Frac}_t \cdot Surp_{h,t} + \varepsilon_{h,t}$.
Data sources: Bloomberg, Nasdaq OMX and the Riksbank.
Note: h refers to the horizon in quarters. For the first-stage results, see table 4. ***, ** and * refer to significance at the 1%, 5% and 10% levels respectively.

for our question of interest, and are hence not discussed further here.

The coefficient $\gamma_{5,h}$ captures the extra effect a surprise has if it is in the direction that closes the existing disagreement, or discrepancy, between the Riksbank's forecast and the market expectations. The estimates are significantly larger than zero for some horizons, suggesting that at least for some horizons the impact of a surprise might be larger if the surprise is such that the Riksbank's new forecast is more in line with the market expectations. Intuitively it makes sense that a movement closer to the market expectations is viewed as more credible by the market, which is in line with positive coefficients. Although not significant for all horizons, $\hat{\gamma}_{5,h}$ in general have the correct sign. The lack of significance might arise from measurement errors and a small sample, as discussed above.

The estimates of $\gamma_{6,h}$ are significantly smaller than zero for some, mainly short, horizons. This also makes sense intuitively, since the interpretation is that a forecast that is released early within the current quarter is viewed as less credible for each horizon. It is simply the case that there is more time left until the beginning of the calendar quarter that the horizon refers to. It also makes sense that the effect is larger for shorter horizons, since the relative difference caused by the release date within the quarter is larger the shorter the horizon is.

The main question of interest is what impact a surprise in an announced repo-rate path has on market expectations of the future repo rate, i.e. the partial derivative $\frac{\partial Impact_{h,t}}{\partial Surprise_{h,t}}$. We recall equation (11), and by using the results from table 5 we can conclude the following; $\hat{\beta}^S_h$ is probably a good approximation of the effect we are interested in if we complement it with information on whether the surprise closes or opens the disagreement and where in the quarter the announcement is placed, slightly dependent on which horizons we are mainly interested in.

Regardless of whether one finds the specification with a large set of control variables, presented in table 5, or the more scarce specification presented in table 4 more reliable, the overall impression of matching equation (2) to data is that it seems like the Riksbank has the ability to affect market expectations with the repo-rate path. The effect is however small or zero beyond one-and-a-half years, and even for shorter horizons the effect is not one-to-one. Less than half of a surprise is reflected in the expectations, and the effect is decreasing with the horizon. These results may be viewed as lower bounds, since there is reason to suspect biased estimates of β^S_h towards zero due to regression dilution because of measurement errors.

Managing the expectations up to about half a year might be more effectively done by surprising with the repo-rate decision. One should also bare in mind that the surprise in the repo-rate decision is highly positively correlated with the surprise in the very short horizon of the repo-rate path, so in practice, a combination of path and decision surprise is often the case.

Even with the more extensive set of controls, there is still reason to worry about omitted-variables bias. Especially, I would like to include controls for the surprise in other information released by the Riksbank simultaneously as the announcement of the repo-rate path and decision. As mentioned above, this includes forecasts for other macroeconomic variables and analysis of the current economic situation. However, this is unobserved and difficult to proxy, and hence I have no other choice than to leave it omitted. This might bias the estimates of interest, and it is difficult to guess the sign and size of such a potential bias.

3.2 Robustness

This section will discuss the robustness of the results presented in section 3.1. I introduce a control for the within-day movement caused by other macroeconomic news than the announcement. I will also look at other measures of the surprise of an announcement than those defined in equations (7) and (8). I show that the results hold when a proxy for a time-and-horizon-specific premium is introduced. I also compare the measures of anticipated announcements presented in section 2.2 to a survey performed before each announcement. The control variables are relaxed one at the time to investigate the importance of each, and finally I try to analyse how robust the results are over time, which is difficult with such a small sample.

In order to overcome the problems arising from potential impact of other macroeconomic news arriving within announcement days, I impose a proxy for the impact of news other than the announcement by the Riksbank. The proxy I use is the daily movement of the Norwegian FRA rates. Economic and financial conditions are very similar in the neighbouring countries Norway and Sweden, and hence there is reason to believe that the Norwegian FRA market should react similar as the Swedish FRA market to news, at least that is not Swedish-specific or Norway-specific in its nature. Both Norway and Sweden are small open economies, and hence influenced largely by international news. The short-term rates, both in the interbank markets and the treasury bill markets, are highly correlated. During the period of interest, there have been no coinciding days of policy-rate announcements in the two countries. Hence, including the $Impact_{h,t}$, as defined in equation (5), for Norway as a control variable in $X_{h,t}$ in equations (1) and (2) might capture the non-announcement effect, if there is one.[19] This is possible since the Norwegian and Swedish FRAs are constructed the exact same way, with the same settlement dates. Table 6 in appendix C shows the regression results of including the term $+\gamma_{7,h} \cdot Impact^{NO}_{h,t}$ in equation (10). In Norway, FRAs are only available for a horizon of 8 quarters, hence the quarters 9–11 have been excluded. As before, the first stage regression is not altered and is hence excluded. The effect on the results is very limited, indicating either that the daily FRA rates are good enough at isolating the effect of an announcement or that the impact on Norwegian FRAs is not good enough at capturing the effect of other news. It is also worth noting that the coefficient for the impact on Norwegian FRAs is non-significant for most horizons.

I now turn to the measure of the variable $Anticipated_{h,t}$, and hence indirectly the variable $Surprise_{h,t}$. So far, these have been defined in two ways, either by equations (6) and (7) or by the regression equation (8) (together with (9)). I will investigate two more cases, suggested in Moessner and Nelson (2008); the path that the market expects the Riksbank to announce is given by the market pricing of the FRAs just prior to the announcement, and the path that the market expects the Riksbank to announce is the same as the one that was announced previously by the Riksbank. More formally,

$$Anticipated_{h,t} = FRA_{h,t-\epsilon} - Path^{RB}_{h,t_p} \quad \text{and} \tag{12}$$

$$Anticipated_{h,t} = 0 \tag{13}$$

[19] An endogeneity problem might also arise, if the announcement by the Riksbank also has an impact on the market expectations of future Norwegian policy rates. We would have what Angrist and Pischke (2008) refer to as a "bad control". This is not unrealistic, since monetary policy is typically highly correlated in Norway and Sweden. However, including a dummy variable for the announcement days of Norges bank, the central bank of Norway, in the regression equation (3) gives estimates that are not significantly larger than zero for any horizons except the 12-quarter horizon. This suggests that at least the Swedish market is not affected much by the communication of Norges bank, so one might expect the reverse to be true as well.

respectively. In the first case, the market's expectation of communication and action by the Riksbank coincides. The market disregards the history of, often systematic, discrepancy between the Riksbank forecast and the market expectations, and expects the Riksbank to fully change its forecast to be in line with the market's expectations. This is what Svensson (2015) refers to as *full predictability*. The second case assumes that the anticipated change in the Riksbank's communication is zero. Kuttner (2001) and Gürkaynak et al. (2005) argue that this is not likely the case. Both these assumptions might seem extreme and unrealistic, but have the advantage of being simple in construction, and are hence worthwhile investigating. Note that when equation (12) or (13) are used, there is no need for a first-stage regression.

A summary of the results of the first case, expected communication coincides with market expectations, i.e. the anticipated change in the communicated path is given by equation (12), are given in table 7 in appendix C. Note that the R^2 is similar compared to the main results in table 5, and also the estimates of β_h^S are quite similar. However, also the estimates of β_h^A are in general significantly larger than zero, suggesting that this specification probably is not as good as the one used in the main analysis.

The results of the other alternative case, when the communicated path is expected not to change since the previous announcement, i.e. the anticipated change in the communicated path is zero, are summarised in table 8. Note that this is a regression of equation (1) rather than equation (2), since the anticipated change is defined to be zero in this case. The estimates of β_h are very different from the main results. This entire case is difficult to interpret and does not add much to the conclusion. However, it serves to emphasize the importance of finding a good measure of the anticipated and unanticipated parts of the Riksbank communication.

One obvious drawback of using FRAs as a measure of expectations of the future repo rate is that it might contain different kinds of premia, which was briefly discussed in section 2.2. In the main analysis, I compensate for a *time-and-horizon-fixed* aggregate premium. An assumption that the premium does not change over time and is the same for all horizons might be too strong. Without commenting further on the type or nature of these possible premia, I follow Ferrero and Secchi (2009) in an attempt to allow the aggregate premium to vary over time and horizons. The idea is that, although market rates like the FRAs might contain premia, survey expectations should not. Hence I construct the varying horizon-specific premium as the difference between FRA rates and the expected future repo rate according to a survey.[20] The survey is not conducted on the same dates as the announcements by the Riksbank, so I use linear interpolation in the time dimension to get a timely estimate. Also, the survey only concerns horizons of 1, 4 and 8 quarters. Linear interpolation is used also in the horizon dimension to get estimates for intermediate horizons. I extrapolate beyond 8 quarters by simply using the value of the 8-quarter horizon. Figure 5 in appendix C shows how these measures of the premium have evolved during the period of interest.

Table 9 presents the results when the varying premium is used. In line with Ferrero and Secchi (2009), the estimates of β_h^S are slightly higher for most short

[20] A monthly survey performed by TNS Sifo Prospera (prospera.se) is used, where about 50 money market participants, mainly Swedish but also international, are asked to quantify their beliefs on different macroeconomic developments, including the repo rate, for different horizons. Up until the third quarter of 2009 the survey was conducted only quarterly.

horizons. The R^2 is also increased for some short horizons. Overall, the picture of the transmission mechanism of the repo-rate path remains when the time-varying premium is used. One perhaps notable thing is that the estimates of $\gamma_{1,h}$, the impact of a surprise in the repo-rate decision, is significantly larger than zero only for the 1-quarter horizon, suggesting that the repo-rate decision might be an even worse instrument for affecting expectations beyond the immediate future.

It is important to beware that using a time-varying premium, defined the way I have, does not resolve the problem that the announcement might have an effect on the premium itself, see equations (4) and (5). This weakness remains, but as has been mentioned above, it might not be important to distinguish between affecting expectations or the premium – in both cases the forward rates move, which might be the aim.

Now to the question of whether my measure of the anticipated (by the market) repo-rate path is good. As mentioned above, the market's expectation of which repo-rate path will be announced by the Riksbank, just prior to the announcement, is unobserved. I have however defined and used two different proxies, one defined by equations (6) and (7) and the other defined by regression of equation (8) and then using equation (9), plus two robustness checks presented above. One way of verifying the quality of these proxies is to compare them with surveys of the Riksbank's expected communication, although this is concerned with other potential problems. One such survey exists, where the Swedish commercial bank SEB asks the largest Swedish bond-market investors approximately one week prior to a new Riksbank announcement about their quantitative beliefs regarding not only the *actions* by the Riksbank but also regarding the *communication*, specifically the announcement of a repo-rate path. The survey doesn't cover the entire path, but typically asks about three specific horizons, and is hence not suitable as a substitute for the proxies used in this study. However, it is interesting to compare these specific observations to the proxies I use.

Figure 6 plots expectations of the announced path according to the survey and according to the proxy in equation (8), where each colour represents a horizon. Running simple regressions where the proxy is explained by the survey and a constant suggest that we cannot reject the hypothesis that the coefficient is one for the survey measure and the constant is zero.[21] The results hold also when the proxy is defined by equations (6) and (7). From this I conclude that the survey gives reason to believe that the proxies for path surprises used in this study are valid.

A very interesting question, that has been left untouched so far, is whether the results are robust over time. Detmers and Nautz (2012) use similar methods and find that the ability of the Reserve Bank of New Zealand to affect market expectations with the policy-rate path has declined since the outbreak of the financial crisis in 2008. Unfortunately, this sample is too small to make any advanced exercises on the subject, like distinguishing between the periods before and after the outbreak of financial crisis. However, the results are robust to leaving out periods of one year at the time.

[21] This corresponds to all observations being on the 45-degree line in figure 6.

4 Conclusions

Market expectations of future monetary policy, as measured by futures rates, tend to move more than normal on days when the Riksbank announces a new repo-rate path, raising the question of what ability the Riksbank has to manage such expectations with the repo-rate path. I have used regression analysis to investigate whether unanticipated changes in the repo-rate path impact the market expectations of the future repo rate on different horizons. There are no perfect measures of neither the anticipation of an announced repo-rate path nor the expected future repo rate, so proxies for these are constructed. The proxy for expected future action, i.e. the future repo rate, is standard in the literature, and my results suggest that the proxy used for anticipated communicated path is valid.

The results of the regressions indicate that the Riksbank has the ability to use the repo-rate path to affect market expectations up to between one and three years. The effect is less than one-to-one and decreasing with the horizon.

For very short horizons, one and two quarters, a surprise in the repo-rate decision might be more effective at managing expectations. A combination of surprises in the decision and path, which is typically the case, seems to be an effective way to manage expectations.

The impact of a path surprise might be even larger if the surprise is in such a direction that it closes the gap between the Riksbank's announced forecast and the market expectations. If the surprise should be such that the gap is widened further, the impact might be smaller. Also the timing within the calendar quarter of the announcement might affect the size of the impact, especially for short horizons.

There is a risk that the estimated effects are biased towards zero due to measurement errors in the proxy for surprise in the repo-rate path. Another potential source of biased estimates is that I have no means of controlling for the impact of surprises in other information released by the Riksbank in the same announcement as the repo-rate path and decision. Such information include forecasts of other macroeconomic variables and an analysis of the current economic situation. It is difficult to guess the size and sign of such a potential bias.

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A Repo-rate paths and market pricing

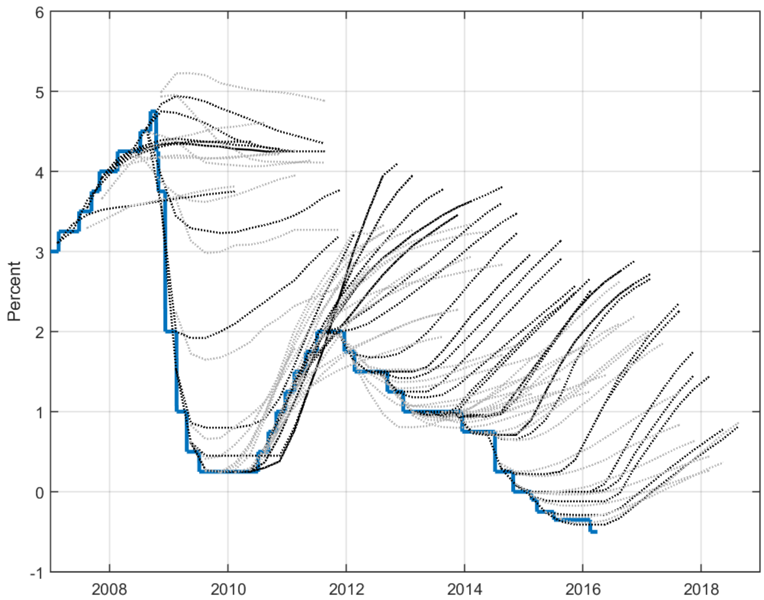

Figure 4: The evolution of the repo rate (thick blue) and forecasts by the Riksbank (black) and the market (grey) as quarterly averages at announcement dates.

B Surprise in the repo-rate decision

One of the control variables that are included in the main analysis is the surprise component of a repo-rate decision. This is the difference between the change that is anticipated by the market just prior to a Riksbank announcement and the actual change of the repo rate at that announcement. Note that the surprise can be non-zero even if the change of the repo rate is zero, if the anticipated change is non-zero. The anticipated change is unobserved, and hence so is the surprise. However, market pricing data provides a good proxy for the anticipated change, and the method used to create this proxy is described in this appendix.

The method described here is the same as the Riksbank uses and has been using for many years. However, the details have never been published and are hence given here. The method is loosely built on Krueger and Kuttner (1996).

I use interest rate swaps to determine the surprise component of a repo-rate decision. The swaps I use are 30-day STINA-swaps, with the STIBOR T/N as the underlying variable part.[22] The way the STINA-swap works is that it breaks even if the (geometrical) average STIBOR T/N from $t+2$ to $t+32$ equals

[22]STIBOR T/N is a Swedish inter-bank interest rate used for overnight loans stretching from the next day to the day after that.

the swap rate. This makes the STINA-swap rate the expected average of the STIBOR T/N rate over the duration. I disregard any swap premia, which I have reasons to believe are very close to zero in this case.

In turn, the STIBOR T/N rate is typically very close to the repo-rate plus a fixed premium of 10 basis points.[23] In cases where the premium deviates from the normal 10 basis points, I make an implicit assumption that it will not be affected by the repo-rate announcement.

When a new repo rate is announced, it is not implemented until the next Wednesday after the day before the announcement. When using the STINA swaps to measure the expected repo-rate change, I will consider two periods; the period from the announcement to the implementation of the (potentially) new repo-rate (I) and the period from the implementation to the settlement day of the STINA-swap (II). I exploit that the repo rate is known during period I, and once the decision is announced it is also known in period II.[24] I consider the change in the STINA-swap rate from just prior to an announcement at time t ($i_{t-\epsilon}^{\text{STINA}}$) to just after the announcement (i_t^{STINA}), and let τ_I and τ_{II} denote the number of days of period I and II respectively.[25] We have

$$1 + i_t^{\text{STINA}} \cdot \frac{30}{360} = \left(1 + \text{E}_t\left[i_I^{\text{T/N}}\right] \cdot \frac{1}{360}\right)^{\tau_I} \left(1 + \text{E}_t\left[i_{II}^{\text{T/N}}\right] \cdot \frac{1}{360}\right)^{\tau_{II}},$$

where $i_I^{\text{T/N}}$ and $i_{II}^{\text{T/N}}$ are the STIBOR T/N rates in periods I and II respectively, by the assumption that the STINA-swap interest rate is the expected average of the STIBOR T/N over the duration. Taking natural logarithms and using the known approximation that $\ln(1+x) \approx x$ when x is small, we get

$$i_t^{\text{STINA}} \cdot \frac{30}{360} \approx \text{E}_t\left[i_I^{\text{T/N}}\right] \cdot \frac{\tau_I}{360} + \text{E}_t\left[i_{II}^{\text{T/N}}\right] \cdot \frac{\tau_{II}}{360} \quad \Longleftrightarrow$$
$$i_t^{\text{STINA}} \approx \frac{\tau_I \text{E}_t\left[i_I^{\text{T/N}}\right] + \tau_{II}\text{E}_t\left[i_{II}^{\text{T/N}}\right]}{30}.$$

Equivalently, we have

$$i_{t-\epsilon}^{\text{STINA}} \approx \frac{\tau_I \text{E}_{t-\epsilon}\left[i_I^{\text{T/N}}\right] + \tau_{II}\text{E}_{t-\epsilon}\left[i_{II}^{\text{T/N}}\right]}{30}.$$

This gives us, for the change in the STINA-swap rate,

$$\begin{aligned} i_t^{\text{STINA}} - i_{t-\epsilon}^{\text{STINA}} &\approx \frac{\tau_I \text{E}_t\left[i_I^{\text{T/N}}\right] + \tau_{II}\text{E}_t\left[i_{II}^{\text{T/N}}\right] - \left(\tau_I \text{E}_{t-\epsilon}\left[i_I^{\text{T/N}}\right] + \tau_{II}\text{E}_{t-\epsilon}\left[i_{II}^{\text{T/N}}\right]\right)}{30} \\ &= \frac{\tau_I\left(\text{E}_t\left[i_I^{\text{T/N}}\right] - \text{E}_{t-\epsilon}\left[i_I^{\text{T/N}}\right]\right) + \tau_{II}\left(\text{E}_t\left[i_{II}^{\text{T/N}}\right] - \text{E}_{t-\epsilon}\left[i_{II}^{\text{T/N}}\right]\right)}{30}. \end{aligned}$$

[23] This is a consequence of the facilities offered to banks by the Riksbank.

[24] I am using 30-day swaps and regular repo-rate announcements of the Riksbank are more than one month apart. However, two times during the period of interest the repo-rate has been changed between regular announcement days. If the market expects this to happen, the results may be invalid. Since repo-rate changes between meetings seem to be very rare and difficult to predict, I assume that market expectations rely on this not being the case.

[25] Since the announcements by the Riksbank take place on different weekdays, τ_I and τ_{II} vary, but we always have $\tau_I + \tau_{II} = 30$.

Since the repo rate is known in period I we have $\mathrm{E}_t\left[i_I^{\mathrm{T/N}}\right] = \mathrm{E}_{t-\epsilon}\left[i_I^{\mathrm{T/N}}\right]$, and since it is not expected to change within period II we have

$$\begin{aligned}\mathrm{E}_t\left[i_{II}^{\mathrm{T/N}}\right] - \mathrm{E}_{t-\epsilon}\left[i_{II}^{\mathrm{T/N}}\right] &= \mathrm{E}_t\left[i_{II}^{\mathrm{repo}} + \eta\right] - \mathrm{E}_{t-\epsilon}\left[i_{II}^{\mathrm{repo}} + \eta\right] \\ &= \mathrm{E}_t\left[i_{II}^{\mathrm{repo}}\right] - \mathrm{E}_{t-\epsilon}\left[i_{II}^{\mathrm{repo}}\right] \\ &= Surprise_{0,t},\end{aligned}$$

i.e. the unanticipated change in the repo rate at time t, where η is the premium of the STINA T/N rate. This is where the assumption that the premium is unaffected by the announcement is crucial. Solving finally gives the surprise as a measure of the observed change in the STINA-swap rate,

$$\begin{aligned} i_t^{\mathrm{STINA}} - i_{t-\epsilon}^{\mathrm{STINA}} &= \frac{0 + \tau_{II} Surprise_{0,t}}{30} \qquad \Longleftrightarrow \\ Surprise_{0,t} &= \frac{\tau_{II}}{30}\left(i_t^{\mathrm{STINA}} - i_{t-\epsilon}^{\mathrm{STINA}}\right).\end{aligned}$$

In practice, the Riksbank uses the change in the STINA-swap rate from the day prior to a repo-rate announcement to the end of the announcement day, for technical reasons. The formula then has to be adjusted with another term, since the two STINA swaps compared have different settlement days. The derivation is straightforward and this is also the measure that is used in this study.

C Results of robustness checks; tables and figures

Table 6: Regression results of equation (10) including movement of corresponding Norwegian futures rate as control variable

$h =$	1	2	3	4	5	6	7	8
				Second stage				
β_h^S	0.17^{**}	0.43^{***}	0.36^{***}	0.34^{***}	0.21^{***}	0.12	0.03	-0.02
	(0.07)	(0.13)	(0.10)	(0.08)	(0.06)	(0.07)	(0.12)	(0.09)
β_h^A	0.06^{**}	-0.00	0.02	0.01	0.00	-0.00	0.03	0.05
	(0.03)	(0.05)	(0.05)	(0.04)	(0.03)	(0.04)	(0.03)	(0.03)
$\gamma_{7,h}$	0.49^{**}	-0.21	-0.02	0.13	0.29^{**}	0.17	0.17	0.37^{***}
	(0.20)	(0.32)	(0.38)	(0.23)	(0.13)	(0.13)	(0.14)	(0.11)
R^2	0.93	0.69	0.60	0.69	0.70	0.64	0.52	0.50
p_F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Obs.	36	45	46	48	48	48	46	46

Equation: $Imp_{h,t} = \beta_h^S \cdot Surp_{h,t} + \beta_h^A \cdot \widetilde{Antic}_{h,t} + \gamma_{0,h} + \gamma_{1,h} \cdot Surp_{0,t} + \gamma_{2,h} \cdot \widetilde{\frac{1}{10}\sum_{j \neq h}} Surp_{j,t} + \gamma_{3,h} \cdot D_t^{ELB} + \gamma_{4,h} \cdot \widetilde{Disagr}_t + \gamma_{5,h} \cdot \widetilde{D}_{h,t}^{Closing} \cdot Surp_{h,t} + \gamma_{6,h} \cdot \widetilde{Frac}_t \cdot Surp_{h,t} + \gamma_{7,h} \cdot Imp_{h,t}^{NO} + \varepsilon_{h,t}$.
Data sources: Bloomberg, Nasdaq OMX and the Riksbank.
Note: h refers to the horizon in quarters. The regressions also include the coefficients $\gamma_{n,h}$, $n \in \{0, 1, \ldots, 6\}$. The estimates of these have been left out. ***, ** and * refer to significance at the 1%, 5% and 10% levels respectively.

Table 7: Regression results of equation (10) when the anticipated change of the path is given by (12)

$h=$	1	2	3	4	5	6	7	8	9	10	11
β_h^S	0.15**	0.24***	0.44***	0.29***	0.20***	0.10**	0.05	−0.06	−0.03	0.07	0.07
	(0.06)	(0.08)	(0.09)	(0.05)	(0.05)	(0.05)	(0.06)	(0.07)	(0.08)	(0.07)	(0.07)
β_h^A	0.05*	0.01	0.10**	0.10***	0.08**	0.10***	0.12***	0.11***	0.08***	0.06	0.06
	(0.03)	(0.06)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.04)	(0.05)
R^2	0.93	0.71	0.69	0.68	0.63	0.57	0.49	0.46	0.36	0.20	0.20
p_F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.34	0.48
Obs.	42	47	47	48	48	48	47	47	47	47	40

Equation: $Imp_{h,t} = \beta_h^S \cdot Surp_{h,t} + \beta_h^A \cdot Antic_{h,t} + \gamma_{0,h} + \gamma_{1,h} \cdot Surp_{0,t} + \gamma_{2,h} \cdot \frac{1}{10} \sum_{j \neq h} Surp_{j,t} + \gamma_{3,h} \cdot D_t^{ELB} + \gamma_{4,h} \cdot \widetilde{Disagr}_t + \gamma_{5,h} \cdot \widetilde{D}_{h,t}^{Closing} \cdot Surp_{h,t} + \gamma_{6,h} \cdot \widetilde{Frac}_t \cdot Surp_{h,t} + \varepsilon_{h,t}$.
Data sources: Bloomberg, Nasdaq OMX and the Riksbank.
Note: h refers to the horizon in quarters. The regressions also include the coefficients $\gamma_{n,h}$, $n \in \{0, 1, \ldots, 6\}$. The estimates of these have been left out. ***, ** and * refer to significance at the 1%, 5% and 10% levels respectively.

Table 8: Regression results of equation (10) when the anticipated change of the path is zero

$h=$	1	2	3	4	5	6	7	8	9	10	11
β_h	0.11***	−0.03	−0.03	0.17**	0.26***	0.26***	0.18**	0.13*	−0.00	0.00	0.01
	(0.03)	(0.08)	(0.08)	(0.07)	(0.06)	(0.08)	(0.08)	(0.07)	(0.07)	(0.07)	(0.06)
R^2	0.94	0.52	0.43	0.49	0.58	0.56	0.43	0.34	0.26	0.13	0.13
p_F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.09	0.59	0.56
Obs.	42	47	47	48	48	48	47	47	47	47	48

Equation: $Imp_{h,t} = \beta_h \cdot Surp_{h,t} + \gamma_{0,h} + \gamma_{1,h} \cdot Surp_{0,t} + \gamma_{2,h} \cdot \frac{1}{10} \sum_{j \neq h} Surp_{j,t} + \gamma_{3,h} \cdot D_t^{ELB} + \gamma_{4,h} \cdot \widetilde{Disagr}_t + \gamma_{5,h} \cdot \widetilde{D}_{h,t}^{Closing} \cdot Surp_{h,t} + \gamma_{6,h} \cdot \widetilde{Frac}_t \cdot Surp_{h,t} + \varepsilon_{h,t}$.
Data sources: Bloomberg, Nasdaq OMX and the Riksbank.
Note: h refers to the horizon in quarters. The regressions also include the coefficients $\gamma_{n,h}$, $n \in \{0, 1, \ldots, 6\}$. The estimates of these have been left out. ***, ** and * refer to significance at the 1%, 5% and 10% levels respectively.

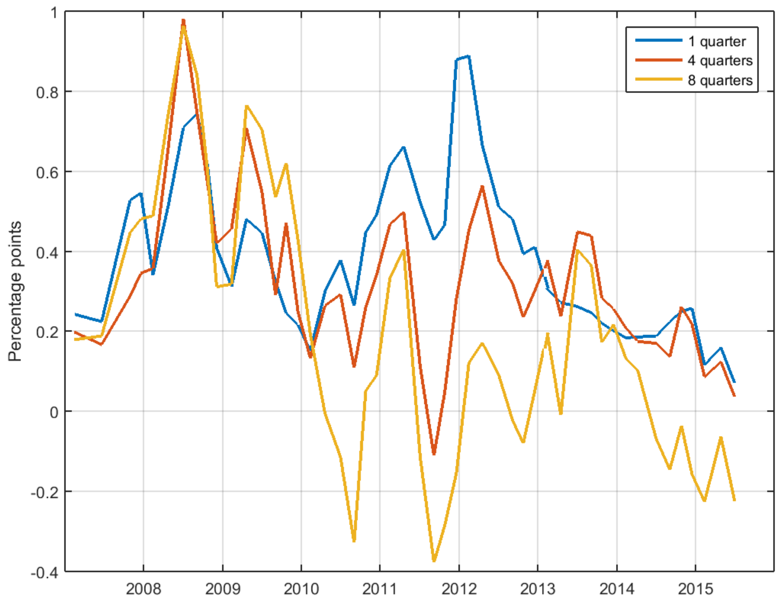

Figure 5: Time-varying premia constructed as the difference between market pricing and a survey.

Table 9: Regression results of equation (10) with a time-and-horizon-varying premium illustrated in figure 5

$h =$	1	2	3	4	5	6	7	8	9	10	11
					Second stage						
β_h^S	0.32***	0.36***	0.41***	0.41***	0.25***	0.18***	−0.05	−0.10	−0.15	−0.03	−0.03
	(0.06)	(0.08)	(0.08)	(0.08)	(0.05)	(0.05)	(0.12)	(0.11)	(0.11)	(0.07)	(0.05)
β_h^A	0.07*	0.04	0.04	0.06	0.05	0.02	0.05	0.06**	0.07**	0.08	0.07
	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.05)	(0.05)
$\gamma_{1,h}$	0.51***	0.26	0.07	0.18	0.16	0.14	−0.07	−0.09	−0.07	0.04	0.01
	(0.10)	(0.16)	(0.17)	(0.13)	(0.11)	(0.13)	(0.16)	(0.16)	(0.13)	(0.18)	(0.12)
R^2	0.94	0.80	0.70	0.71	0.68	0.65	0.50	0.44	0.39	0.14	0.17
p_F	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.67	0.46
Obs.	36	46	46	48	48	48	46	46	46	46	48
					First stage						
α_h	−0.03	−0.05*	−0.08**	−0.13***	−0.14**	−0.14**	−0.08	−0.03	0.00	0.01	−0.02
	(0.04)	(0.03)	(0.03)	(0.05)	(0.06)	(0.07)	(0.08)	(0.09)	(0.12)	(0.15)	(0.15)
μ_h^M	1.26*	0.97	0.91	0.90	0.86	0.80*	0.76**	0.67***	0.60***	0.51***	0.47***
	(0.14)	(0.09)	(0.08)	(0.09)	(0.10)	(0.11)	(0.10)	(0.08)	(0.08)	(0.07)	(0.08)
$\mu_h^{M_p}$	−0.64	−0.44***	−0.49***	−0.53***	−0.51***	−0.43***	−0.36***	−0.25***	−0.22***	−0.17***	−0.20***
	(0.26)	(0.13)	(0.12)	(0.15)	(0.13)	(0.12)	(0.12)	(0.11)	(0.12)	(0.12)	(0.10)
μ_h^P	0.39***	0.53***	0.64***	0.70**	0.72***	0.71***	0.66***	0.63***	0.65***	0.70**	0.78**
	(0.21)	(0.14)	(0.10)	(0.11)	(0.10)	(0.08)	(0.09)	(0.10)	(0.12)	(0.12)	(0.09)
R^2	0.99	0.99	0.99	0.98	0.97	0.96	0.96	0.96	0.96	0.96	0.96
Obs.	36	46	46	48	48	48	46	46	46	46	48

First stage: $Path_{h,t}^{RB} = \alpha_h + \mu_h^M \cdot FRA_{h,t-\epsilon} + \mu_h^{M_p} \cdot FRA_{h,t_p} + \mu_h^P \cdot Path_{h,t_p}^{RB} + Surprise_{h,t}$.

Second stage: $Impact_{h,t} = \beta_h^S \cdot Surprise_{h,t} + \beta_h^A \cdot Anticipated_{h,t} + \gamma_{0,h} + \varepsilon_{h,t}$.

Data sources: Bloomberg, Nasdaq OMX, the Riksbank and TNS Sifo Prospera.

Note: h refers to the horizon in quarters. In the first-stage regression, significance levels refer to significant difference from the reference levels $(0, 1, -1, 1)$ for $(\alpha_h, \mu_h^M, \mu_h^{M_p}, \mu_h^P)$ respectively. The regressions also include the coefficients $\gamma_{n,h}$, $n \in \{0, 2, 3, \ldots, 6\}$. The estimates of these have been left out. ***, ** and * refer to significance at the 1%, 5% and 10% levels respectively.

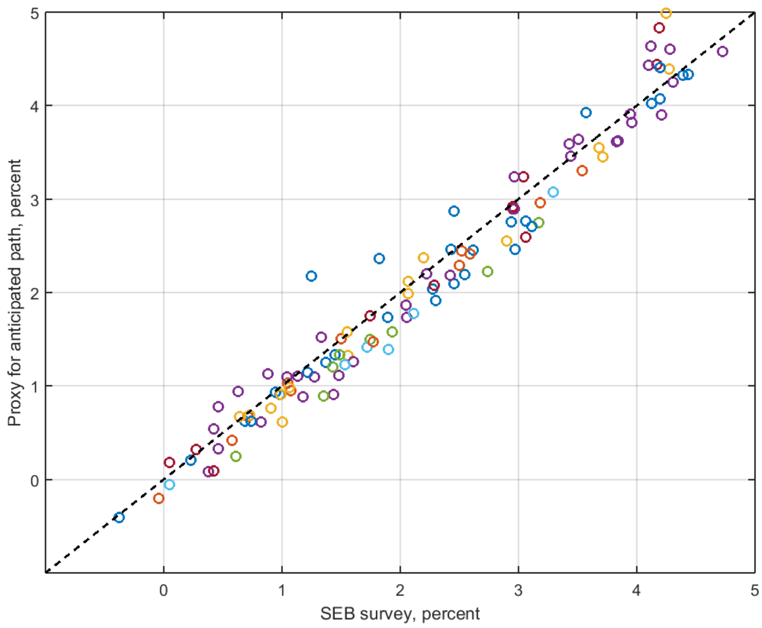

Figure 6: Comparison of a survey measure of expected communicated repo-rate path and the proxy used in the quantitative exercises. Each colour represents a horizon.

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