Policy Interest-Rate Expectations in Sweden: A Forecast Evaluation[*]

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Abstract

In this paper, we evaluate two types of Swedish policy interest-rate expectations: survey expectations and expectations inferred from market pricing. The data are drawn from the most prominent survey of financial-market economists and from Swedish financial markets and the data are carefully matched by date to ensure comparability. Results show that both kinds of expectations suffer from bias and inefficiency and in terms of forecast precision there is no clear winner. We do find, though, evidence that the forecast accuracy of both kinds of policy-rate expectations has improved since the Riksbank started publishing its own policy-rate forecast, suggesting that this communication strategy has been beneficial from a policy perspective.

Summary in Swedish

I denna studie utvärderas två typer av reporänteförväntningar: enkätför-
väntningar och förväntningar baserade på marknadsprissättning. Data
kommer från Sveriges viktigaste enkätundersökning av finansmarknads-
ekonomer och från svenska finansiella marknader; dessa har matchats
noggrant efter datum så att de är jämförbara. Resultaten visar att båda
typerna av förväntningar har problem med ineffektivitet samt frånvaro
av väntevärdesriktighet och i termer av prognosprecision finns ingen klar
vinnare. Vi finner dock tecken på att prognosprecisionen hos båda ty-
perna av förväntningar har förbättrats sedan Riksbanken började publi-
cera sin egen reporänteprognos. Detta indikerar att denna kommunikat-
ionsstrategi har varit förmånlig ur ett policyperspektiv.

Contents

1. Introduction

Monetary policy hinges upon the management of expectations. Woodford (2003, p. 15) characterises this view as "*not only do expectations about policy matter, but, at least under current conditions, very little else matters*". In inflation-targeting economies, expectations about key macroeconomic variables including inflation, output growth and policy interest rates are of wide interest to policy makers, analysts and forecasters. Two important measures of private-sector expectations are survey expectations and expectations inferred from market pricing. The two measures have different benefits and shortcomings. Survey-based measures are often criticised for their lack of financial incentives for respondents to give thoughtful forecasts; see, for example, Gürkaynak and Wolfers (2005). Measures based on market pricing, on the other hand, are sensitive to empirical assumptions about credit spreads and risk premia. For example, interest-rate and inflation expectations inferred from derivatives contracts and bond yields rely upon assumptions about risk premia that are difficult to observe in good times and even harder to assess during times of financial turbulence; see Galati *et al.* (2011) for a discussion.

The purpose of this paper is to evaluate the forecasting properties of survey and market-based policy interest-rate expectations in Sweden. The analysis speaks to several questions. First, do private-sector expectations possess reasonable properties? For example, bias is a warning sign and inefficiency signals shortcomings in the way expectations are formed or measured. Second, which expectations should policy makers rely upon when the various measures of expectations do not coincide? Here, the relative forecast precision of the measures might be informative. In recent years, discrepancies between survey- and market-based expectations measures have arisen in several countries, including Sweden. Figure A1 in the appendix – which replicates parts of the information of a figure from the Riksbank's October 2010 *Monetary Policy Report* – illustrates the discrepancy between the survey-based and market-based expectations as well as the discrepancy with the Riksbank's own interest-rate forecast.

Third, and most contentiously, should the central bank publish its own policy-rate projection?[1] Proponents of this policy argue that communicating the policy-rate path helps economic agents better understand monetary policy and grants the central bank more influence over longer-term interest rates, thereby improving the central bank's ability to achieve its macroeconomic objectives. Opponents argue that the policy-rate path is too uncertain to warrant being published and risks being interpreted as a statement of commitment. Nor has academic research arrived at a consensus. Some recent research, suggests that publishing the path might be beneficial, or at least not detri-

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[1] There is a fairly lively discussion among both academics and policy makers concerning the limits to central bank transparency; see, for example, Morris and Shin (2002), Svensson (2006), Blinder *et al.* (2008), Rudebusch (2008), van der Cruijsen *et al.* (2010) and Ehrmann *et al.* (2012).

mental for economic outcomes; see, for example, Moessner and Nelson (2008), Rudebusch and Williams (2008) and Andersson and Hofmann (2010). However, Dale *et al.* (2011) argue that if the central bank publishes poor-quality forecasts then ultimately it risks becoming a source of distraction that is detrimental to the private sector's forecast precision.[2] With the benefits uncertain, few central banks have so far chosen to publish policy-rate forecasts so there is accordingly little data with which to assess the effect on private-sector policy expectations. Sveriges Riksbank took the step relatively early – in February 2007 – thereby becoming one of the first central banks with an endogenous policy rate projection.[3] Comparing policy-rate forecast precision before and after this date can shed light on the effect of the communication policy.

Our results show that the private sector's policy-rate expectations are neither unbiased nor efficient forecasts. Concerning forecast precision, we find there is no clear winner between survey expectations versus those inferred from market pricing. Interestingly, though, we find evidence that the forecasting precision of all types of policy-rate expectations has increased modestly since the Riksbank began publishing its own policy-rate projection.

The rest of this paper is organised as follows. Section 2 describes the data, Section 3 presents the empirical analysis and Section 4 concludes.

2. Data

Our data span the period September 2002 to January 2012 and are drawn from the most prominent survey of financial-market forecasters, *Prospera*, and from Swedish financial markets. We consider two real-time measures of expectations inferred from market pricing, one which has been calculated by the Riksbank using various financial contracts and assumptions about term premia (measure A) and another using only forward rate agreements and standardised assumptions about credit-market spreads and term premia (measure B). To ensure comparability of the information sets, expectations based on market pricing are calculated on the same dates the *Prospera* survey was conducted.

Survey-based expectations: The *Prospera* survey has been conducted four times each year and collects information from households, firms and forecasters working in financial markets. We fo-

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[2] Dale *et al*. (2011) considered inflation forecasts in a highly stylised model but argue that this principle applies more broadly.

[3] The Reserve Bank of New Zealand was the true pioneer when it comes to endogenous interest rate forecasts, publishing endogenous rate forecasts from 1998. Interestingly, though, it publishes its projection of the 90-day bank bill rate, not its own policy rate (the official cash rate). In October 2005, Norway began publishing endogenous projections of the policy rate. Most recently, in January 2012, the Federal Reserve began publishing the end-of-year policy-rate forecasts of individual FOMC members.

cus on the latter set of respondents, denoted "money-market players", of which there are typically 40 to 50 respondents. Respondents give their forecast of the Riksbank's policy rate at several horizons, from one quarter up to 5 years, and we use the average forecast in our analysis.

Expectations inferred from market pricing: Market interest rates embed not only policy expectations but also credit spreads and risk premia that reflect the nature of the financial instrument and the investment horizon. The forecast accuracy of market-inferred policy expectations thus depend both on the ability of the market to forecast the central bank's policy actions and the accuracy of the spread and premia adjustments.[4] In light of this, we consider two market-based measures for Sweden:

Measure A: Policy-rate expectations inferred historically by the Riksbank using smooth Nelson-Siegel type curves (Nelson and Siegel, 1987; Svensson, 1995) fitted to a range of financial instruments, including government bond yields, forward rate agreements (FRAs) and interest-rate swaps and futures. The underlying financial instruments and the assumptions about credit spreads and risk premia have varied over the years to suit data availability and market conditions. Using the parameters of the fitted curves, we extract policy expectations at exactly 3, 12 and 24 months ahead.

Measure B: Policy-rate expectations measured from FRAs without curve fitting but with a consistent real-time method for adjusting for credit spreads and a standardised interest-rate risk premia assumption. We use the fourth and eighth FRA contracts as indicators of policy expectations one and two years ahead.[5] FRAs do not settle directly on the Riksbank's policy rate but on a three-month interbank borrowing rate which embodies a credit spread for term bank lending. We extract real-time estimates of the anticipated interbank three-month credit spread by comparing derivatives which settle on overnight rates in the future with those that settle on three-month rates.[6] Finally, we assume a rule of thumb interest-rate risk premium of 1.5 basis

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[4] The presence of premia which make forward rates poor predictors of market rates is well documented in the literature; see, for example, Chernenko et al. (2004), Alsterlind and Dillén (2005) and Piazzesi and Swanson (2008).

[5] Because of the construction of the FRA, it is unsuitable to use the first FRA contract as a measure of expectations at the one-quarter horizon. We accordingly do not use it in this paper.

[6] Specifically, we observe rates on 3, 6, 9 and 12 month overnight indexed swaps which settle on overnight interbank borrowing rates for the following day. These contracts reflect expectations about average tomorrow-next interbank rates over the contract's life. Converting these rates to forward rates spanning 6-to-9, 9-to-12 and 6-to-12 months, it is then possible to compare the rates to those on FRA contracts that reflect expectations about 3-month interbank borrowing rates. This comparison is made immediately before IMM-settlement dates so that the contract horizons match. The difference between the overnight and three-month forward rates reveals the market's anticipation of the spread between three-month and overnight interbank borrowing rates 6 to 12 months ahead, that is, the extra compensation needed for taking on term bank credit risk in the future. We assume that the anticipated 6-to-12 month term credit spread ahead is a good indication of the same spread anticipated at 12 and 24 months ahead. We also subtract a further 10 basis points from the FRA rates (the sample average) which reflects the sample average spread between overnight interbank rates and the Riksbank's repo rate. Overlapping data on FRAs and overnight indexed swaps are available from September 2002. The data are sourced from Reuters.

points per month, amounting to 0.18 and 0.36 percentage points at 12 and 24 months respectively.[7]

The survey-based and marked-inferred expectations are evaluated against outcomes of the Riksbank's policy rate – the repo rate – up to and including January 2012; the history of the policy rate is shown in Figure 1. Three different forecast horizons are evaluated – one quarter, one year and two years – with 38, 35 and 31 data points respectively. Figures A2 to A4 in the appendix show the forecast errors, defined as actual repo rate minus expectation, at the three horizons.

Figure 1. Repo rate in Sweden.
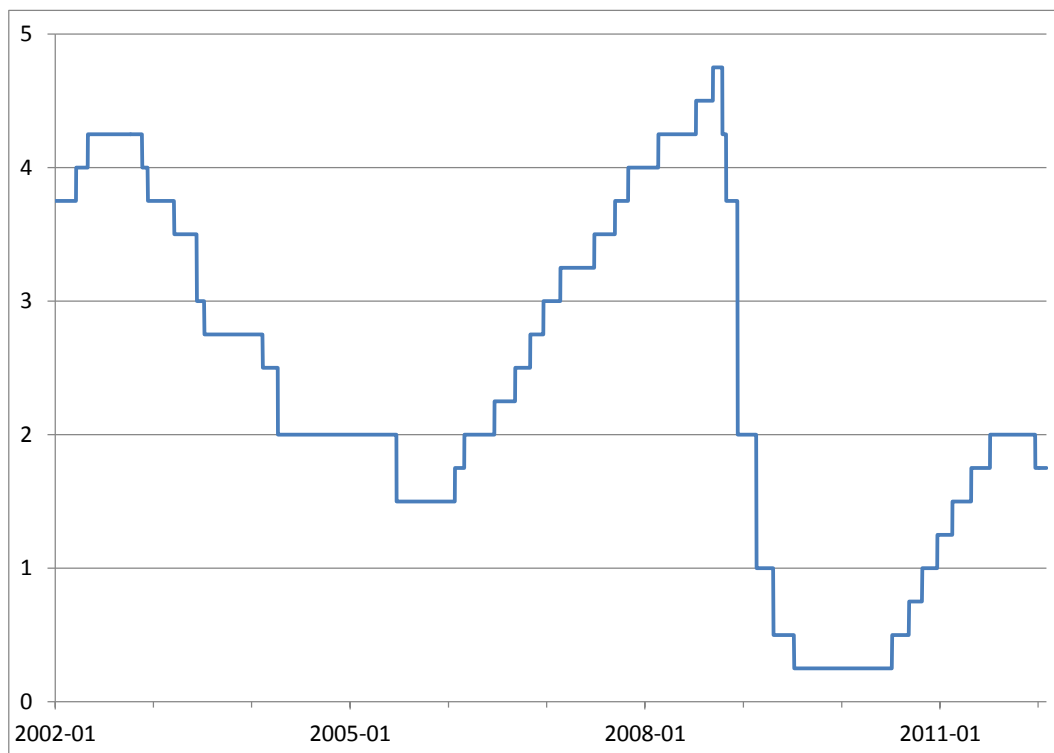
3. Empirical analysis

Our empirical analysis is divided into three parts. First, we test for unbiasedness and efficiency. Second, we evaluate the forecast accuracy of policy-rate expectations. These two stages are standard in the literature on forecast evaluation; see, for example, Mehra (2002), Mankiw *et al.* (2003), Baghestani (2008) and Jonsson and Österholm (2011). Third, we compare the forecast precision of poli-

cy-rate expectations in two subperiods to assess the impact of the Riksbank's communication strategy of publishing its own policy-rate projections.

3.1 Unbiasedness and efficiency

Defining the forecast error as $e_{t+h|t} = i_{t+h} - i_{t+h|t}$, where i_{t+h} is the actual repo rate at time $t+h$ and $i_{t+h|t}$ is the forecast made at time t, the first column of Table 1 reports the mean errors. As is common in the macroeconomic literature, we also include a naïve forecast as a neutral benchmark. As can be seen, all mean errors are negative, indicating that all measures of expectations at all horizons have been too high on average. The size of the mean error is larger the longer the forecast horizon. At the one-quarter horizon, average over-prediction ranges from -0.09 to -0.14 percentage points. At the two-year horizon, *Prospera* and market expectations have mean errors between -1.53 and -1.19. The naïve forecast attracts a less pronounced mean error – it is only -0.56.

Does this over-prediction constitute a significant bias? This can be tested by running the regression

$$e_{t+h|t} = \lambda + \omega_t \tag{1}$$

where $e_{t+h|t}$ is defined as above and ω_t is an error term. The null hypothesis $H_0 : \lambda = 0$ is then tested using Newey-West standard errors.[8] As can be seen from Table 1, all measures at all horizons are biased at reasonable significance levels, except the naïve forecast. This bias is to some extent driven by the large forecast errors associated with the sharp easing of monetary policy during the financial crisis. However, while these forecast errors constitute part of the explanation, they are probably not the only cause for our findings.[9]

Biased forecasts constitute a violation of rational expectations under the commonly employed assumption that the forecaster has a symmetric quadratic loss function for the forecast errors. However, in reality we never know the loss function and therefore make no such claims here.[10] Instead we simply note that this result could be considered a warning sign regarding the rationality of the expectations formation process.

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[8] Newey-West standard errors are used to address the serial correlation in the residuals (which occurs by definition at the one- and two-year horizons when using quarterly frequency data).

[9] In order to investigate this, we conducted some additional regression analysis. At the one-quarter horizon, there is only one large forecast error associated with the crisis. Allowing for a dummy variable to remove the influence of this, there is still a significant bias for the Prospera data. Detailed results are not reported but are available upon request.

[10] Recall that biased forecasts can be rational, for example if forecasters have asymmetric loss functions; see Elliott *et al*. (2008) for a discussion.

Table 1. RMSEs and results from tests of bias and efficiency.

	Mean error	Efficiency	RMSE	Theil's U
1 quarter				
Prospera	-0.14[b]	-0.11	0.46	0.82
	(0.07)	(0.08)		
Market measure A	-0.13[c]	-0.12	0.46	0.82
	(0.07)	(0.08)		
Market measure B	-	-	-	-
Naive	-0.09	-	0.56	1.00
	(0.12)			
1 year				
Prospera	-0.65[b]	-0.50[a]	1.24	0.81
	(0.30)	(0.11)		
Market measure A	-0.73[b]	-0.53[a]	1.35	0.89
	(0.33)	(0.19)		
Market measure B	-0.59[c]	-0.52[b]	1.27	0.83
	(0.31)	(0.19)		
Naive	-0.26	-	1.53	1.00
	(0.45)			
2 years				
Prospera	-1.30[b]	-0.95[a]	2.08	0.93
	(0.53)	(0.30)		
Market measure A	-1.53[a]	-1.02[a]	2.30	1.03
	(0.55)	(0.27)		
Market measure B	-1.19[b]	-0.99[a]	2.07	0.93
	(0.55)	(0.27)		
Naive	-0.56	-	2.23	1.00
	(0.71)			

Note: "Mean error" gives $\hat{\lambda}$ from equation (1). "Efficiency" gives $\hat{\beta}$ from equation (2). Newey-West standard errors in parentheses (). [a], [b] and [c] indicate significance at the one, five and ten percent level respectively. Regressions have 38, 35 and 31 observations at the one-quarter, one-year and two-year horizons. Theil's U is the relative RMSE between a given expectation and a naïve forecast. If the expectation has a lower RMSE than the naïve forecast, Theil's U is accordingly less than unity.

Next, we test for efficient use of macroeconomic data when forming policy-rate expectations. A straightforward test of efficient use of data is based on the regression

$$e_{t+h|t} = \alpha + \beta_1 i_t + v_t, \qquad (2)$$

where i_t is the repo rate at time t and v_t is an error term. Since i_t was in the information set at time t, efficient use of data requires that it cannot explain variation in the forecast error. The null

hypothesis $H_0 : \beta = 0$ is tested using a standard *t*-test again with Newey-West standard errors. Results are given in Table 1.

One- and two-year ahead policy expectations prove to be inefficient forecasts in that they do not make full use of the information contained in the current policy rate. While bias – as noted above – is not necessarily a sign of lack of rationality, inefficient use of data is incompatible with rational expectations. One-quarter horizon expectations do, however, appear to be efficient with respect to the current policy rate.

3.2 Forecast accuracy

As the next step in our assessment of the policy-rate expectations, we compare the forecasting accuracy of the various measures. RMSEs are presented in the third column of Table 1. Glancing through the table, in terms of RMSEs there is no clear winner between survey-based and market-inferred measures of policy expectations. At the one-quarter horizon, *Prospera* and market-pricing measure A enjoy the same RMSE. At the one and two-year horizons, the RMSEs of the *Prospera* data and market-pricing measure B are very similar in size. Measures A and B of expectations inferred from market pricing differ in their forecast accuracy, likely due to different practices in adjusting for credit spreads and risk premia. In all cases but one – market-pricing measure A at the two-year horizon – the RMSEs are lower than the naïve forecast.

We test more formally for differences in forecasting precision using a modified Diebold and Mariano test under the assumption of a quadratic loss function.[11] This is based on the regression

$$\left(e_{t+h|t}^{P}\right)^2 - \left(e_{t+h|t}^{M}\right)^2 = \delta + \chi_t \tag{3}$$

where $e_{t+h|t}^{P}$ and $e_{t+h|t}^{M}$ are the forecast errors of the *Prospera* survey and the market expectations respectively and χ_t is an error term. The null hypothesis is that the forecasting accuracy of the *Prospera* survey is equal to that of the market-inferred expectations. This is tested by comparing a transformation of the *t*-statistic on $\hat{\delta}$ to the relevant critical value from the *t*-distribution. The results in Table 2 show that the null hypothesis can be rejected only for *Prospera* versus market-pricing measure A at the two-year horizon.

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[11] We use the modified test of Harvey *et al*. (1997) rather than the orignial one suggested by Diebold and Mariano (1995) since our samples are fairly small.

Overall, the survey-based and market-inferred measures of policy expectations tell similar stories about the path of policy expectations and realised forecast errors. At the one- and two-year horizons, all types of expectations underpredicted the extent of policy tightening that would occur during 2006 and 2007 and going into the financial crisis, all measures failed to predict the abrupt loosening of monetary policy during late 2008 and early 2009. Extracting policy expectations from market pricing is particularly difficult during times of financial turbulence, large portfolio reallocations and extraordinary central bank measures. Given these difficulties, it is remarkable that the survey and market-inferred measures have been so similar. Indeed, based on a decade of data, there is little evidence to suggest that either survey-based or market-based expectations are superior in forecast ability.

Table 2. Results from Diebold-Mariano test.

	S^*
1 quarter	
Market measure A	0.67
Market measure B	-
1 year	
Market measure A	-1.48
Market measure B	-0.52
2 years	
Market measure A	-1.78[c]
Market measure B	0.20

Note: S^* is the tests statistic from the modified Diebold and Mariano test of Harvey *et al.* (1997). [a], [b] and [c] indicate significance at the one, five and ten percent level respectively. Regressions have 38, 35 and 31 observations at the one-quarter, one-year and two-year horizons.

3.3 Forecast accuracy and central bank communication

As described in the introduction, publishing central bank interest-rate projections is a contentious issue policy. The Riksbank began publishing its own policy-rate forecast in February 2007 and has soon reached five years with this policy. Has this materially affected the nature of private-sector policy expectations? As the final step in our assessment of repo rate expectations in Sweden, we evaluate the forecast precision of policy expectations before and after the new communication strategy.

Specifically, we focus on the one-quarter ahead expectations and split the sample in two parts around February 2007: Period 1 spans September 2002 to January 2007 and Period 2 spans May

2007 to September 2011, each period containing 19 observations.[12] By focussing on the one-quarter ahead expectations we take advantage of the largest possible number of observations for the exercise.[13]

Table 3 reports RMSEs for the full sample (column 1) and subsamples (columns 2 and 3). Comparing the two subsamples, RMSEs are actually larger post February 2007; this owes entirely to the exceptional error of the September 2008 forecast made just prior to the collapse of Lehman Brothers. In the following three months, and before even the next survey opportunity, the Riksbank cut interest rates by 2.75 percentage points. The sharp drop in the policy rate was a surprise not only for private forecasters but also for the Riksbank itself, whose own policy-rate projection from early September 2008 did not foresee impending cuts.

Excluding just the September 2008 forecast error as an outlier, the RMSE of the post-February 2007 sample drops substantially, to about half of its pre-February 2007 size. Importantly though, it should be noted that unlike the survey-based and financial-market inferred expectations, the RMSE of the naïve forecast is almost the same in the two samples. This suggests that something happened specifically amongst private-sector forecasters rather than to the macroeconomic environment more generally.

Table 3. RMSEs from one-quarter-ahead forecasts from different time periods.

	Sept 2002-Sept 2011	Sept 2002-Jan 2007	May 2007-Sept 2011	May 2007-Sept 2011 No outlier
Prospera	0.46	0.23	0.61	0.14
Market measure A	0.46	0.23	0.61	0.12
Naive	0.56	0.34	0.72	0.35

The number of observations is small in both sub-samples so, to assess whether the differences in the pre- and post-communication strategy RMSEs are significant, we turn to a bootstrap exercise.[14] It is conducted the following way:

I.   For a given measure – *Prospera* or Market measure A – generate a Period 1 bootstrap sample with 19 observations by sampling (with replacement) squared forecast errors from the original sequence of squared forecast errors originating from the period September 2002 to January 2007.

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[12] January 2007 is the date of the last *Prospera* survey conducted before the Riksbank's change in communication strategy and May 2007 the date of the first survey conducted after this change.

[13] The one-step-ahead forecast is also the the horizon studied by Dale *et al*. (2011).

[14] More traditional tests would require a larger number of observations than we have available here.

II. For a given measure, generate a Period 2 bootstrap sample with 18 observations by sampling (with replacement) forecast errors from the original sequence of squared forecast errors originating from the period May 2007 to September 2011 (excluding the outlier).

III. For a given measure, calculate $D^i = RMSE_1^i - RMSE_2^i$, that is, the difference in RMSEs between "Period 1" and "Period 2" for measure i.

IV. Repeat steps I to III 20 000 times.

This provides us with two bootstrap distributions for differences in RMSEs between the two periods – one for each measure. If a difference of zero or smaller is found to be rare, we conclude that the observed difference in RMSEs is statistically significant. It turns out that for the *Prospera* expectations, 4.9 percent of the bootstrap sample has an RMSE difference that is smaller than zero. The corresponding number for Market pricing A is 1.1 percent (see Figure 2). Hence, for both measures the drop in RMSEs between the pre- and post-communication samples is significant at conventional levels, but the evidence is stronger for the market-inferred expectations.

Figure 2. Bootstrap distributions of RMSE differences between periods.
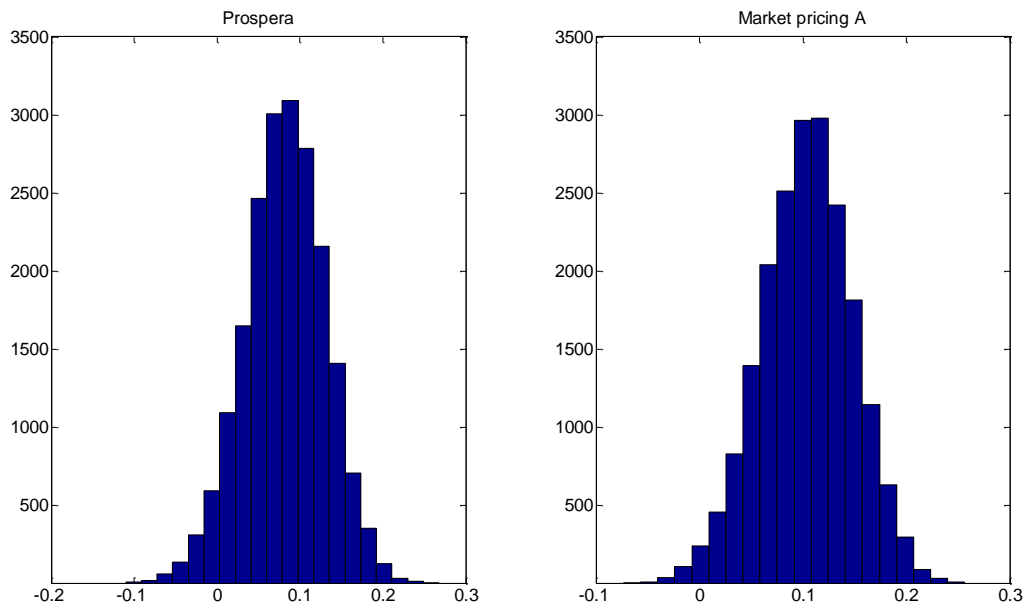
Note: The difference is given on the horizontal axis and is defined as the Period 1 RMSE minus the Period 2 RMSE. 20 000 bootstrap replications were conducted for each distribution.

Summing up this exercise, we find evidence that the Riksbank's policy of communicating its policy-rate forecasts has been associated with an increase in private-sector policy-rate forecast precision.

Whether the policy has been causal or the improvement owes to other factors is difficult to establish. Given the financial and economic turbulence that has emerged since 2007 it is hard to argue that the forecast environment has become more stable or benign, leaving open the possibility that the Riksbank's communication policy has indeed assisted forecasters. That central-bank forecasts affect private-sector forecasts is consistent with the information-revealing role of the central bank – see, for example, Romer and Romer (2000) – and of importance for the management of interest-rate expectations.

4. Conclusions

In this paper, we have evaluated the forecasting properties of repo rate expectations in Sweden. At the one and two-year forecast horizons, both survey-based measures and market-pricing inferred measures of policy-rate expectations are biased and inefficient. These results are perhaps not too surprising given that survey-based forecasts of Swedish inflation and wage-growth have been shown to have similar shortcomings; see Jonsson and Österholm (2011, 2012). And despite the frequently cited disadvantages of both types of policy expectations, neither stand out as a clear winner concerning forecast accuracy.

Our results also indicate a modest improvement in the forecast precision of near-term policy expectations of private actors since the Riksbank began publishing its own policy-rate projection. This finding adds some empirical evidence to the discussion of the costs and benefits of central banks publishing their own policy-rate forecasts, a discussion that to date has largely been theoretical. A likely mechanism is that by making its forecasts more transparent the central bank provides information about its reaction function and methods that private-sector forecasters can employ in their own assessments. While our results should not be over-interpreted – we present evidence for one country – they are suggestive that the publication strategy yields benefits.

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Appendix

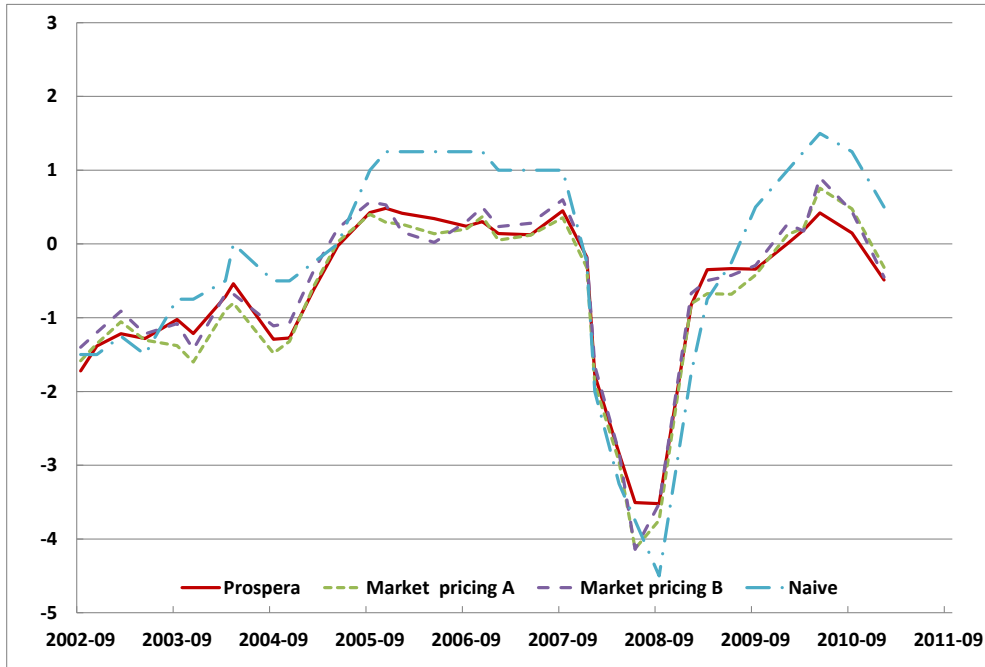**Figure A1. Repo rate, Riksbank forecast and market expectations in Sweden, October 2010.**
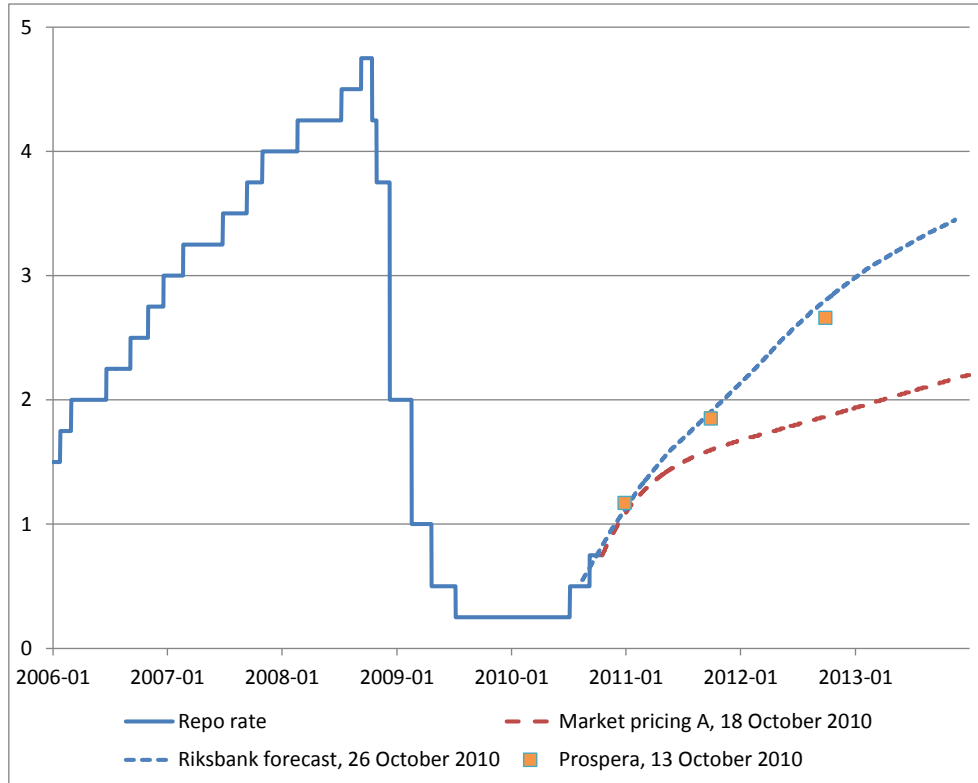
Note: This figure replicates parts of the information of Figure 1:8 in the Riksbank's October 2010 *Monetary Policy Report*.

Figure A2. Forecast errors at the one-quarter horizon.
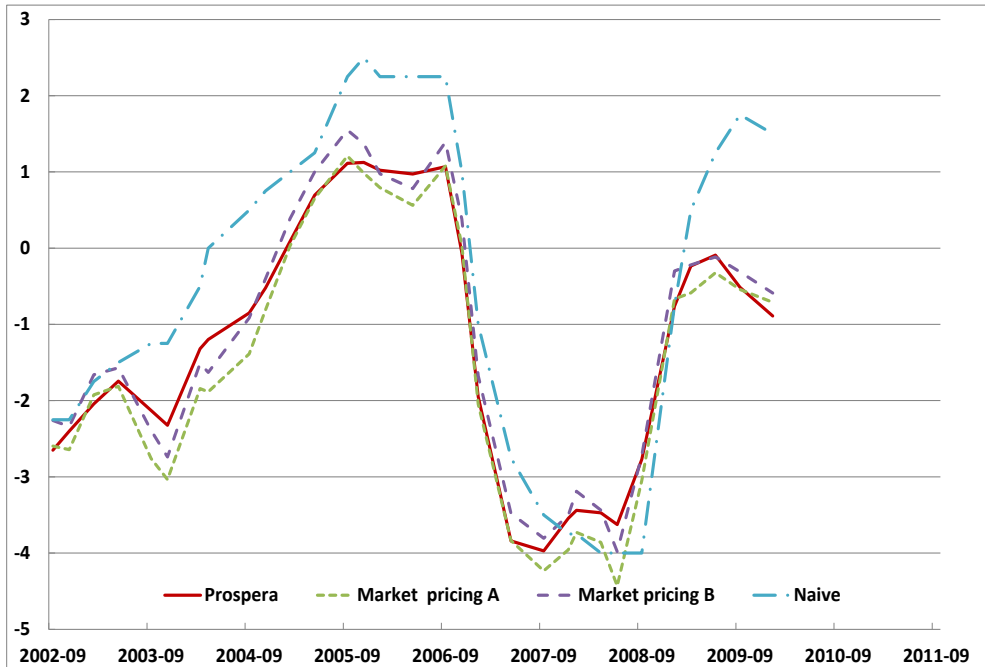

Note: Date refers to when forecast was made

Figure A3. Forecast errors at the one-year horizon.

Note: Date refers to when forecast was made

Figure A4. Forecast errors at the two-year horizon.

Note: Date refers to when forecast was made.

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