

Olsson, Kerstin

Working Paper

How do monetary policy announcements affect inflation expectations?

Working Paper, No. 2020:2

Provided in Cooperation with:

Department of Economics, Uppsala University

Suggested Citation: Olsson, Kerstin (2020) : How do monetary policy announcements affect inflation expectations?, Working Paper, No. 2020:2, Uppsala University, Department of Economics, Uppsala, <https://nbn-resolving.de/urn:nbn:se:uu:diva-409534>

This Version is available at:

<https://hdl.handle.net/10419/249371>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



UPPSALA
UNIVERSITET

Department of Economics
Working Paper 2020:2

*How do monetary policy announcements
affect inflation expectations?*

Kerstin Olsson

Department of Economics
Uppsala University
Box 513
751 20 Uppsala
Sweden

Working Paper 2020:2
April 2020
ISSN 1653-6975

HOW DO MONETARY POLICY ANNOUNCEMENTS AFFECT INFLATION EXPECTATIONS?

KERSTIN OLSSON

How do monetary policy announcements affect inflation expectations?*

Kerstin Olsson[†]

April 18, 2020

Abstract

This paper examines the effects of policy rate announcements on households' inflation expectations over the time period 2003-2015. The effect is estimated using a two-stage least squares regression model. The announced changes are instrumented by a monetary policy surprise variable obtained from high-frequency swap trade data. The effect of an announced increase in the policy rate on inflation expectations is significant and positive. According to the New-Keynesian model, the effect of an exogenous monetary policy shock depends on the assumptions made on the persistence of the shock process in the model. Alternatively, the results may be interpreted as the policy announcement signalling the central bank's private information on the direction of future inflation. Given the sizeable weight of housing costs in the Swedish CPI basket, the results may also be interpreted as reflecting the direct effect of interest rates on the CPI. In this case, households internalize the effects of interest rates on CPI, when forming expectations about the future rate of inflation.

Keywords: Monetary policy, Inflationary expectations, Instrumental Variables, Event studies

JEL Classification: C26, E31, E52, G14

*I would like to thank my supervisors Nils Gottfries and Stefan Pitschner, as well as Mikael Carlsson, Georg Graetz, Maria Sandström and the seminar participants at the Department of Economic at Uppsala University for valuable comments, suggestions and discussions. I am grateful to the National Institute of Economic Research in Sweden for the provision of survey data and to the Wallander-Hedelius-Browaldh foundation for financial support .

[†]Department of Economics, Uppsala University. E-mail: kerstin.olsson@nek.uu.se

1 Introduction

Agents' inflation expectations are an important part of the transmission channel through which the central bank's monetary policy actions affect the economy. Inflation expectations affect inflation outcomes and economic activity through firms' price setting decisions and the wage demands posed by unions and workers. Furthermore, an increasing number of central banks have adopted inflation targets during recent decades and the idea that effective communication of monetary policy contributes to shaping agents' expectations has been highlighted. Shaping expectations is closely related to the central bank's ability to keep the rate of inflation close to its' target. Goodhart (2001) and Archer (2005) argue that inflation targeting central banks are particularly dependent on the perception of their monetary policy decisions and communication, which further highlights the importance of agents' expectations.

One of the aims of having an inflation target is to anchor agents' inflation expectations to the target. If expectations are firmly anchored, the central bank can reduce uncertainty and ease the agents' economic decision making. Given that the announced policy actions are deemed credible by the agents, they will keep their expectations close to the target rate even if disturbances temporarily push inflation away from the target. One of the main tools through which the central bank conducts its policy is its policy rate. The overall importance of inflation expectations together with the importance of the central bank's ability to shape expectations naturally leads to the question: How do monetary policy rate announcements affect inflation expectations?

The purpose of this paper is to answer this question by using survey data on inflation expectations to examine one aspect of the expectations transmission channel. In particular, this paper studies the effects of monetary policy rate announcements on inflation expectations. As announcements may be anticipated by agents, this paper examines the effects of unexpected policy rate changes on inflation expectations. The empirical examination is carried out through an event type of study, using Swedish monthly household survey data over the time period 2003-2015. The effect of announced changes to the Riksbank's policy rate (the repo rate) on households' inflation expectations is studied. Sweden provides a useful basis for this type of study, given its long history with an explicit inflation target and a relatively stable rate of inflation. The Riksbank is consistently working to achieve a transparent and efficient communication of the intentions of its policy actions, e.g. by regularly publishing (since 2005) the trajectory of the forecasted path of its future policy rate, together with forecasts of key macroeconomic variables. In fact, the Riksbank is deemed to be one of the most transparent central banks in the world (Eichengreen and Dincer, 2010).

The survey data of inflation expectations includes observations collected during three days before and three days after 29 policy rate announcements made by the Riksbank. Since households may anticipate announcements, an instrumental variable approach is applied. The repo rate changes are instrumented by a measure reflecting the unexpected component of the announced policy rate change. This monetary

policy surprise measure is obtained from high-frequency swap trade data, which are collected during a narrow time window around the repo rate announcements.

The results show that repo rate announcements have a significant positive effect on inflation expectations, indicating that households increase their inflation expectations in response to an announcement by the Riksbank to increase the repo rate. A positive response of inflation expectations is not consistent with the negative relationship predicted by the New-Keynesian model, with parameter values as in Galí (2015). The New-Keynesian model suggests that, provided that the monetary policy shock is persistent, but not too persistent, an increase in the nominal interest rate should be associated with a decrease in inflation expectations. However, if the monetary policy shock is assumed to be highly persistent, the correlation between unexpected changes in the interest rate and inflation expectations switches sign and becomes positive, in line with the estimated results.

An alternative interpretation is that the announcement may reveal private information of the central bank about the state of the economy. In this case, an unexpected increase in the interest rate may be taken as information that the central bank expects inflation to increase in the future, leading households to increase their inflation expectations. A final interpretation is that the results reflect the fact that interest rates enter directly in the Swedish consumer price basket via housing costs. The results may therefore be interpreted as households internalizing the direct effect of repo rate changes on mortgage interest rates into their inflation expectations. This could also cause inflation expectations to respond in the same direction as an unexpected change of the repo rate.

To the best of my knowledge, no previous paper has studied the direct effect of monetary policy rate announcements on the inflation expectations of households over a longer period of time. In a recent study, Coibion et al. (2019) conduct a randomized controlled trial on US individuals during three months of 2018 to examine the effect of different forms of information signals on inflation expectations, such as the Federal Open Market Committee statements. In contrast to their study, this paper considers the effects of monetary policy announcements on household inflation expectations over a longer time period using a survey data sample covering 13 years. A number of studies have indirectly examined the effects of monetary policy announcements on inflation expectations by studying the effect of central bank communication on financial markets and interest rates (see Blinder et al., 2008, for a survey). In contrast to these studies, this paper studies the direct effect of monetary policy announcements on inflation expectations.

Some previous studies have examined other aspects of central bank communication and inflation expectations. Szyszko (2015) studies the effect of inflation forecasts published by central banks on consumers' inflation expectations, finding that central banks are able to shape expectations by publishing inflation forecasts. Dräger (2015) studies the effects of media reports about inflation on the inflation perceptions and expectations of Swedish consumers. Dräger shows that media reports about inflation have small effects on expectations, and that consumers care more about news of rising inflation than about news of falling inflation.

In general, empirical studies of the effects of monetary policy announcements on the expectations held by the general public are, to date, few in numbers. Most previous research has focused on the inflation expectations of financial market participants and professional forecasters (e.g. Kuttner, 2001; Andersson et al., 2006; Amstad and Fischer, 2009). Yet, many central banks aim to explicitly communicate their actions to the general public. Clear communication with the general public is essential for the accountability and democratic legitimacy of an independent central bank (Binder, 2017). In addition, consumers' inflation expectations are often found to differ from those of professional forecasters and financial market participants (Carroll, 2003; Coibion and Gorodnichenko, 2015), and these differences may have important economic implications due to the sizeable impact of households' consumption decisions on the general performance of the economy. Consequently, if the central bank's communication is able to influence household's inflation expectations, it will also affect consumer behavior, inflation outcomes, and economic activity.

The following section provides a theoretical background, against which the results will be interpreted. Section 3 presents the survey data on inflation expectations, gives a brief overview of the Riksbank's communication policy and decision process, and summarizes the previous literature on measures of monetary policy shocks together with a brief explanation of how the monetary policy surprise variable is constructed. Section 4 explains the empirical estimation method and regression results are presented. Section 5 considers robustness checks. Section 6 examines whether the effect is heterogeneous across types of households, and section 7 concludes.

2 Theoretical Background

The standard New-Keynesian model with Calvo (1983) pricing provides a useful theoretical baseline to interpret the empirical results.¹ Using the standard notation, as in Galí (2015), the three key equations of the model are as follows:

$$\pi_t = \beta E_t \pi_{t+1} + \kappa \hat{y}_t \quad (1)$$

$$\hat{y}_t = -\frac{1}{\sigma} (i_t - E_t \pi_{t+1} - r_t^n) + E_t \hat{y}_{t+1} \quad (2)$$

$$i_t = \rho + \phi_\pi \pi_t + \phi_y \hat{y}_t + \nu_t \quad (3)$$

where π_t is inflation, $E_t \pi_{t+1}$ is the expected inflation, \hat{y}_t denotes the output gap, $E_t \hat{y}_{t+1}$ the expected output gap, i_t the nominal interest rate, r_t^n the natural interest rate. The exogenous component of the monetary policy, ν_t , is assumed to follow the AR(1) process $\nu_t = \rho_\nu \nu_{t-1} + \varepsilon_t^\nu$ is the process which the exogenous monetary policy shock, ε_t^ν . A monetary policy shock, ε_t^ν , generates an unexpected change in the interest rate. As a monetary policy shock hits the economy, the agents expects the central bank to act according to the policy rule given by equation (3).

With the calibration used in Galí (2015), and under the assumption of a moderately persistent shock

¹For detailed presentation of the model, see e.g. chapter 3, Galí (2015).

($\rho = 0.5$) the central bank responds to a positive shock, ε_t^ν , by increasing the period t nominal interest rate, which leads to a decrease in output and inflation. This, in turn, implies a simultaneous dampening of the upward adjustment of the nominal interest rate. Provided that the shock is persistent inflation expectations are predicted to decrease.

However, if the shock is assumed to be highly persistent the effect via expectations outweighs the direct effect of the shock, and the interest rate and inflation expectations both decrease (see p.67 in Galí, 2015). The sign of the predicted correlation between unexpected changes in the nominal interest rate on inflation expectations is therefore ambiguous, and depends on the assumptions made about the persistence of the monetary policy shock.

Unexpected changes to the nominal interest rate may not only reflect exogenous monetary policy shocks. Unexpected changes may be endogenous if there is an information asymmetry between the central bank and the agents. In this case, the change in the nominal interest rate may reveal private information of the central bank. One such model is developed by Ellingsen and Söderström (2001). In their model, the central bank sets out to minimize a loss function by choosing the one-period nominal interest rate. Unanticipated changes in monetary policy can come about for two reasons. First, if the central bank responds to new and private knowledge about shocks to output and prices, the policy response of the central bank is endogenous as it reflects new input into a given objective function. In this case, an unanticipated increase in the nominal interest rate may be interpreted by market participants as an indication that inflation has increased. As a result, interest rates of all maturities, as well as inflation expectations, are predicted to increase as the central bank acts to fight inflation. Ellingsen and Söderström (2001) suggest that private information may be interpreted as central banks having superior data processing abilities, rather than earlier access to data than market participants.

Second, the central bank's preferences may change. In this case, the policy change is exogenous in the sense that the weight placed on inflation versus output stabilization in the central bank's objective function is changed. For instance, if the nominal interest rate is increased and market participants are confident that there has been no unanticipated change in fundamentals, then they may infer that inflation stabilization has moved higher on the central bank's agenda. In Ellingsen and Söderström (2001) model, sufficiently long interest rates, and thus inflation expectations as well, are then predicted to move in the opposite direction to the change in the interest rate, as inflation is reduced.

In summary, the predicted relationship between an unexpected change in the nominal interest rate and inflation expectations may either be positive or negative, in response to an exogenous monetary policy shock, depending on the persistence of the monetary policy shock. Unexpected changes in the nominal interest rate may also reflect endogenous policy responses of the central bank to private information about the state of the economy. In this case inflation expectations will respond positively to an increase in the interest rate.

3 Data

3.1 Inflation Expectations

Inflation expectations data over the time period April 2003 to April 2015 are obtained from the Swedish Consumer Tendency Survey (CTS) which is compiled on a monthly basis by the Swedish National Institute of Economic Research (NIER).² The data provide individual expectations about the expected average rate of inflation over the coming 12 months. In addition to recording observations of inflation expectations and the date the survey interview took place, a number of characteristics of the respondents are recorded as well such as their age, gender, and geographical region of residence.

The survey data are collected during the first two weeks of each month, and the number of interviews are uniformly distributed over the interview period. Each of the monthly samples contains 1500 interviews. The interviews are conducted by a computer program over the phone, and the selection of the sample is adjusted each month to be representative in terms of gender, age and geographical region of residence among Swedish households. Responses are collected until a predetermined quota in each of the three categories is filled. The households are asked to provide both a qualitative indication of the expected direction of future price change over the next 12 months, and a point estimate. In this paper, the survey responses to the latter question are considered.³

To isolate changes in inflation expectations in response to the announcements rather than other news and changes in the economy, only households interviewed during a time window of three days prior and three days after a repo rate announcement are included in the sample. The narrower the time window around the repo rate announcements is, the more likely it is to capture the effect of the announcement itself. However, narrowing the window too tight around the announcement reduces the number of observations, which makes the estimation less precise. In addition, if it takes time for the news to reach the households, a too narrow window may result in a data set that is not capturing the effect of the announcement at all. Balancing this trade-off, an interview window including three days before and after the announcement of each of the repo rate decision is chosen. Since the individuals interviewed during the day of the announcement may or may not have been exposed to the repo rate announcement news, interviews recorded during the day of the repo rate announcement are excluded. This means that in total six interview days, three before and three after each repo rate announcement are included in the sample.

²The identity of the called interviewee is compared to register data information. To avoid within-household biases, in case a land-line phone number for a non-single household is called, the person chosen to represent the household is the person whose next birthday is closest in future time.

³The question asked to the survey respondents is as follows: "Compared with today, how much in percent do you think that prices will go up (i.e. the rate of inflation 12 months from now)?" The respondents are asked provide a point estimate or a small interval. In case an interval is provided, the point estimate is calculated as the average.

3.2 The Riksbank's announcement and decision process

The Swedish central bank, the Riksbank, is independent of the Swedish parliament and its main objective is to maintain price stability, interpreted as a 2% target rate of inflation. Since 1999 the Riksbank is managed by an Executive Board consisting of six members, of which one is the chairperson and governor (Andersson et al., 2006). The board makes decisions by majority vote, where the governor's vote is pivotal. Normally, six monetary policy meetings are held each year according to a publicly pre-announced meeting schedule. During these meetings the policy rate (the repo rate) is decided. The announcement of the decision is normally made the day after the meeting, in a press conference accompanied by a press release which contains the most important considerations behind the decision (Hallsten and Tägtström, 2009).

The whole process leading up to the policy rate decision takes approximately six weeks long, and starts off from a number of alternative scenarios for the future economic development and potential future risks. Thereafter, new statistics and events that have occurred since the previous monetary policy meeting are analysed. The final decision on the repo rate is, however, taken at the final board meeting. Here the board also decides on the forecast for the repo rate over the next three years. The minutes of the board meeting are published approximately two weeks after the final decision. The minutes provide a record of how each of the members reasoned and voted. Members of the board can state a dissenting opinion concerning the view of the majority on the monetary policy decision or the forecasts presented in a report alongside with the repo rate decision. These reservations are recorded in the minutes (Hallsten and Tägtström, 2009).

Between the monetary policy meetings, the Riksbank communicates to the public by means of speeches, press releases and economic commentaries on their website. Individual board members can give an account of important monetary policy issues, but cannot give account of their own views until the minutes of the final meeting have been published. Speeches by individual board members may contain comments on new statistics and relate them to the earlier forecasts, or describe which variables were particularly important when making the previous repo rate decision. However, the member cannot provide information that would allow outsiders to anticipate the position that the board member will take with regard to the next policy decision (Hallsten and Tägtström, 2009).

During the time period of this study, April-2003 to April-2015, 81 repo rate decisions were announced by the Riksbank. Of these, 29 announcements took place during the first two weeks of the month, i.e. during the interview period of the Consumer Tendency Survey where households inflation expectations are collected. These 29 announcements are considered in this paper. A list of the included decision dates, the announced change and the magnitudes of the associated monetary policy surprises is shown in the appendix, table A1.

3.3 Monetary policy surprises

In the New-Keynesian model, all agents are assumed to have full information. Anticipated changes in the monetary policy rate should not have an effect on inflation expectations since these have already been foreseen and immediately internalized into the expectations of future inflation. Inflation expectations should therefore only change in response to unanticipated announcements. Consequently, an examination of the effect of monetary policy rate announcements on inflation expectations requires a measure of unanticipated changes to the policy rate, i.e. monetary policy surprises.

The next issue at hand is therefore how to obtain such a monetary policy surprise measure. The previous literature considers various ways of estimating the empirical counterpart of a monetary policy shock. Ramey (2016) provides a survey of the methods used in the literature for the identification of macroeconomic shocks in general, and monetary policy shocks in particular. The emergence of high-frequency financial market data has allowed for new methods of identifying unexpected changes in monetary policy; see e.g. Kuttner (2001); Gürkaynak et al. (2005); Hamilton (2008) and Campbell et al. (2012). This paper uses a measure developed by Sandström (2018), who in turn builds on Kuttner (2001), Brubakk et al. (2017) and Gertler and Karadi (2015). The measure uses high frequency data on future rates around monetary policy announcements, which are used to estimate the monetary policy surprise associated with a policy rate announcement.

Expectations of central bank policy actions are not directly observable. However, given the assumption that there exist an observable market interest rate which is a close proxy for the expected monetary policy rate, the expectations of the central bank's policy rate may be measured using market interest rates. In this sense, interest rates on financial instruments may provide a natural, market-based proxy for these expectations (Barakchian and Crowe, 2013; Sandström, 2018). Kuttner (2001) uses Fed funds futures rates to disentangle expected from the unexpected monetary policy actions. Gertler and Karadi (2015) use various interest rate futures. Brubakk et al. (2017) construct a synthetic one-month interest rate instrument by using the relationship between spot and forward exchange rates. Sandström (2018)⁴ considers the STINA (Stockholm Tomorrow Next Interbank Average) swap rate, which represents the exchange of a fixed and a floating rate.⁵

The measure is based on the efficient market hypothesis, which states that asset prices reflect all available information, including expected future monetary policy. In this case, the surprising element of an announced policy change can be estimated by looking at the change in the futures rate just after, as compared to just before an announcement. The time window during which the surprise is measured should be short enough to measure the response to the central bank's announcement and not responses to other information hitting the market. At the same time, the window needs to be

⁴See Sandström (2018), Appendix A, for a detailed derivation her measure of the monetary policy shock.

⁵The floating rate is the STIBOR T/N (Stockholm Tomorrow Next Interbank Offered Rate Tomorrow Next), which is the interbank rate from tomorrow to the day after tomorrow. The STIBOR T/N is generally traded at the central bank's policy rate plus a fixed risk premium of 10 basis points. The fixed rate should be equal to the expected average STIBOR T/N interbank rate over a one-month contract horizon.

long enough to allow markets to receive and digest the announcement. In a fully efficient market, the change is instantaneous. However, interpreting new information may not be instantaneous, and therefore the window should not be too short either (Brubakk et al., 2017; Sandström, 2018).⁶

In practice, the observed interest rate may not be a perfect measure of expected future monetary policy, as it is likely to contain a small risk premium. The proxy interest rate is still an informative measure of the expected policy rate given the assumption that there is no systematic variation in the risk premium during the time of monetary policy announcements. The presence of unsystematic measurement error would lead to an attenuation bias, understating the estimated effects of monetary policy rate changes on inflation expectations (Barakchian and Crowe, 2013; Sandström, 2018).

4 Empirical Analysis

4.1 The Regression Model

The baseline regression equation to test the effect of repo rate announcements on inflation expectations is given by the following equation:

$$\pi_{i,j}^e = \alpha_j + \gamma D_{i,j} + \delta X_j + \varepsilon_{i,j}, \quad (4)$$

where the dependent variable is the inflation expectation of household $i = 1, 2, \dots, N$. The index j indicates during which of the 29 included announcement months the household is interviewed. α_j is an intercept which is specific to announcement month j , $D_{i,j}$ is a dummy variable that takes the value one if household i is interviewed in the three day period *after* the announcement. The inclusion of $D_{i,j}$ controls for systematic compositional differences in the sample between households interviewed in the beginning and the end of an interview window. Systematic differences may arise, for example, if groups with systematically higher expectations are tend interviewed in the beginning or in the end of the sample. The variable of interest, $X_j = D_{i,j} \Delta i_j^{Repo}$, is given by the interaction of the announced change in the repo rate, Δi_j^{Repo} , and the dummy variable, $D_{i,j}$, which takes the value one for households that have been exposed to the announcement (i.e. that are interviewed in the three day period after the announcement). $\varepsilon_{i,j}$ is the error term.

Individuals may anticipate changes in the repo rate and internalize expected changes in their expectations, prior to the announcement. In this case, the regression given by (4) suffers from an errors-in-variables problem, as the unanticipated component of the announced repo rate change is contaminated by the possible presence of anticipation effects. Theoretically, the announced change to the policy rate is the sum of two mutually uncorrelated components: an expected and an unexpected component.

⁶Sandström (2018)'s measure is estimated using a 3 hour window. The monetary policy announcements generally take place at 9:30 am, while changes in the STINA rate are observed between 9:15 and 12:15.

Only the unexpected component should have an effect on expectations, as the expected component is already internalized in expectations. However, the unexpected component is unobserved and the actual policy rate change is used in the regression. Hence, the inclusion of both the expected and the unexpected component in the regressor implies a measurement error, which leads to an attenuation of the estimated effect of a policy rate change on inflation expectations. To distinguish the unexpected from the expected part of an announced change to the repo rate, the monetary policy surprise measure presented in section 3 is used as an instrumental variable in the regression. Assuming that financial markets have at least as much information as households, a policy rate change that is a surprise to the financial markets should be uncorrelated with the repo rate change that is expected by households.

The effect of the announcement is estimated using two stage least squares (2SLS). The first identifying assumption of this approach is that the monetary policy surprise, i.e. the unanticipated component of the announcement, is correlated with the announcement of the repo rate. The second identifying assumption is that the monetary policy surprise affects inflation expectations only via the announcements, that is, it does not have a direct effect on inflation expectations. The third and final identifying assumption is that the monetary policy surprise is uncorrelated with the error term, $\varepsilon_{i,j}$. Together, the fulfilment of these assumptions leads to a consistent estimate of the effect of a repo rate change on inflation expectations, denoted δ in equation 4.

The repo rate is the main policy tool that the Riksbank uses to reach its inflation target, and influencing inflation expectations is an important part of reaching that target. Consequently, the Riksbank may change the repo rate in response to inflation expectations, leading to a correlation between the error term, ϵ , and the change of the repo rate. This potential issue of reverse causality is handled in several ways. First, the included repo rate decisions are taken during the beginning of the month, while the survey data of inflation expectations are published at the end of each month, after the announcement is made. The likelihood that the Riksbank observes the inflation expectations collected just before the announcement of the repo rate decisions is therefore minimal. Second, only interviews conducted during three days closest to the announcements are included in the sample, which further decreases the probability that the Riksbank changes the repo rate in response to inflation expectations observed in the same month as the announcements takes place.

However, reversed causality may still be present if the Riksbank is responding to an observed trend in inflation expectations. For instance, if inflation expectations have been decreasing for several months prior the repo rate decision, expectations may have a negative trend which the Riksbank may respond to. The use of a monetary surprise variable minimizes this problem, since it reflects only the unexpected component of the announcements. The Riksbank's response to a trend in inflation expectations may be anticipated, and should therefore not be reflected in a measure of monetary policy surprises.

4.2 Results

The estimated coefficients of the first stage regression are shown in Table 1. The first stage regression estimates the relationship between the monetary policy surprise and the associated announced change in the repo rate. The estimated coefficient of the monetary policy surprise is significantly different from zero, and the high R-square indicates a strong association between the repo rate change and the monetary policy surprise variable. Both these results are in favor of the relevance of the former variable as an instrument for the latter. Stock et al. (2002) recommend a threshold value of the first stage F-statistic of at least 10 as support in favor of the strength of the instrument. In addition, Stock and Yogo (2005) suggest a threshold value of the Cragg-Donald F-statistic of at least 16.38. The last two rows of Table 1 show that the F-statistics of the first stage regression are well above both these thresholds.

The estimated first stage relationship is not one to one. The large magnitude of the estimated coefficient indicates that a one percentage point increase in the surprise variable is associated with a more than double as large change in the repo rate. Put differently, the estimated coefficient implies that a one standard deviation monetary policy surprise roughly induces a 0.48 percentage points increase in inflation expectations. Theoretically, the announced change is the sum of two mutually uncorrelated components, an unexpected and an expected component. The coefficient on each of these components should therefore be expected to be equal to one. Therefore, the large magnitude of the estimated coefficient is surprising.⁷

Table 1: First stage

| Variables: | dep. var: i_t^{Repo} |
|--------------------------|------------------------|
| $\Delta r^{unexpected}$ | 3.610*** (0.245) |
| Intercept | 0.00366 (0.0217) |
| Observations | 29 |
| R-squared | 0.890 |
| F-statistic | 217.56 |
| Cragg-Donald F-statistic | 89671.5 |

Note: standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 2 shows the OLS and 2SLS estimation results. The first three columns show the OLS estimates, while the last three show the 2SLS estimates. Starting from the leftmost column, the OLS estimate

⁷The unexpected component should not contain any systematic components, and therefore have mean value of zero. However, as is shown in Table A2 in Appendix, the mean of the empirical monetary policy surprise variable is, albeit small in magnitude, different from zero. The large coefficient on the estimated unexpected component may reflect the fact that the monetary policy surprise variable appears to contain a small systematic component.

indicates that inflation expectations increase in response to an announcement of the Riksbank to increase the repo rate. The second column includes the dummy variable, D . The dummy variable controls for common fixed effects of households interviewed after the repo rate announcements. The estimated effect of a repo rate announcement on inflation expectations shown in the second column is only slightly larger than the corresponding estimate in the first column. The third column shows that the inclusion of time fixed effects, i.e. the inclusion of period specific intercepts rather than a common intercept, results in a decreased magnitude of the estimated coefficient. The decrease indicates that a part of the variation in inflation expectations is explained by factors other than the repo rate announcements, which are accounted for by the period-specific intercepts.

Table 2: OLS and 2SLS

| Variables: | OLS | | | 2SLS | | |
|---------------------------|----------------------|----------------------|--------------------|----------------------|----------------------|---------------------|
| | <i>dep. var:</i> | π^e | | <i>dep. var:</i> | π^e | |
| Repo rate announcement | 0.654*** (0.0728) | 0.674*** (0.0755) | 0.298** (0.130) | 0.622*** (0.0837) | 0.647*** (0.0878) | 0.465*** (0.154) |
| After announcement dummy | - | 0.0368 (0.0361) | 0.0712 (0.0596) | - | 0.0333 (0.0365) | 0.0957 (0.0608) |
| Period specific intercept | - | - | ✓ | - | - | ✓ |
| Observations | 36,466 | 36,466 | 36,466 | 36,466 | 36,466 | 36,466 |

Note: standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The fourth to sixth columns show the corresponding 2SLS estimates. The estimate shown in the fourth column is similar in magnitude to the corresponding OLS estimate shown in the first column, and indicates that an announcement to increase the repo rate leads to an increase in inflation expectations. Again, the inclusion of the dummy variable, which controls for common fixed effects of households interviewed after the repo rate announcements, results in a slight increase in the estimated effect of a repo rate announcement on inflation expectations, as is shown in the fifth column.

The inclusion of time fixed effects, as is shown in the sixth column, implies a decrease of the estimated coefficient. The estimated effect shown in the sixth column, implies that a one standard deviation increase in the monetary policy surprise, via the announced change in the repo rate, roughly induces a 0.23 percentage points *increase* in inflation expectations. Compared to the magnitude of the corresponding OLS estimate shown in the third column, the 2SLS estimate is of greater magnitude. The difference in magnitudes is consistent with the presence of an attenuation bias in the OLS estimate, arising due to the noise added from the inclusion of both the anticipated and unanticipated component of the repo rate change. Therefore, the 2SLS estimate shown in the sixth column is estimate at main focus in following the discussion of the regression results.

4.3 Discussion

There are several possible interpretations of the results. In the New-Keynesian model, the correlation between unexpected changes in the policy rate and inflation expectations depends on the assumption made about the persistence of the monetary policy shock. If the shock is moderately persistent, the model predicts that an unexpected increase in the nominal interest rate is associated with a decrease in inflation expectations. The result of this paper is not in line with this prediction, as the estimated effect of an unexpected increase in the repo rate leads to an increase in inflation expectations. If instead the monetary policy shock in the New-Keynesian model is assumed to be highly persistent, the sign of the predicted correlation is reversed and hence positive. Thus, under the assumption of a highly persistent shock, the empirical results may be interpreted in line with the model prediction.

The New-Keynesian model assumes that the central bank and the agents in the economy have full and symmetric information. However, if the central bank has private information about the state of the economy, an unanticipated change in the nominal interest rate may be interpreted as the central bank revealing private information. A second interpretation of the results is therefore that households increase their inflation expectations as the central bank reveals, by increasing the policy rate, that it expects inflation to increase in the future. There may also be other information in the announcement that reveals private information of the Riksbank that induces households to change their inflation expectations.

A third interpretation of the results reflects the direct presence of interest rates in the CPI basket. As mortgage interest rates are included in the Swedish CPI measure an increase in the policy rate will mechanically increase the CPI as well. The effect of a change in the central bank's policy rate on market interest rates is, in turn, in line with the widely accepted stylized facts presented in Christiano et al. (1999), showing that after a contractionary monetary policy shock, short term interest rates increase. In general, an increase in short term interest rates implies an increase in mortgage interest rates as well. The Consumer Tendency Survey asks households to provide their expectations of the rate of change in the general price level over the next 12 months, and the price level is typically measured by the CPI. If households indeed do keep the CPI in mind as they state their inflation expectations, the effect on inflation expectations of an unexpected increase of the repo rate should be positive.

The CPI, which includes interest costs of housing, has been the main target variable for the Riksbank's inflation target until 2017. As of 2017, the official target variable was changed to CPI holding interest rates fixed, the so called CPIF. In fact, the Riksbank has considered this alternative CPI measure as a complement to the main target variable since 2008.⁸ The New-Keynesian model does not include interest rates in the definition of inflation. The deviation of the results, as compared to the effect predicted by the model under the assumption of a moderately persistent shock, may be interpreted as reflecting the sizeable weight given to housing expenditures in the CPI basket (about 25% in 2015), and

⁸The main difference between the two measures is that an index of interest rates multiplied with an index of the capital stock enters into CPI with variable interest rate. While only the capital stock index enters in the alternative CPI measure with fixed interest rates.

to mortgage interest rates in particular. The results may thus be interpreted as households internalizing the effect of e.g. the mortgage interest into their expectations about the future rate of inflation.

5 Robustness

In this section four alternative explanations are explored. First, the global financial crisis resulted in heightened media attention to economic and monetary policy news. The increased attention placed on the central banks' actions may imply that the results are driven solely by decisions announced during the financial crisis. Second, survey data is often suspected of containing extreme and incorrect observations. Regardless of their information content, if a few extreme observations drive the results, the estimated effect may not be representative of the average household. Third, the collection of survey data may result in systematic compositional differences arising in the sample. If systematic differences exist between households interviewed before, as compared to households interviewed after a repo rate announcement, the estimated effect may reflect these differences rather than the response to the announcements. Fourth, inflation expectations are often found to be highly heterogeneous based on the demographic characteristics of the respondents. The presence of heterogeneity in the effect of monetary policy announcements across households may indicate that the main result reflect not the effect on the inflation expectations of the general public, but a certain type of household.

5.1 The Financial Crisis

If monetary policy announcements have a large effect on inflation expectations in certain settings, such as during a financial crisis, but not in others, the results may be driven by events occurring during extreme circumstances. In this case, the estimated effect may be driven by the increased attention given to monetary policy and economic news during the outbreak of the global financial crisis during 2008/2009.

Binder (2017) and Van der Cruijsen et al. (2015) find that households lack the information or motivation to be receptive to central bank communications. While Dräger et al. (2016) highlight the role of media in their study of the relationship between US households' inflation expectations and key economic concepts, such as the Fisher equation, the Taylor rule and the Phillips curve. They find that the consistency between household's expectations and the Taylor rule and the Phillips curve is weak, but increase with newspaper coverage of inflation, unemployment, and monetary policy, and consumers reporting hearing more economic news.

Naturally, the amount of reported monetary policy news in the media was higher during the financial crisis in 2008/2009. The outbreak of the crisis is in the middle of the sample period studied in this paper. To examine the impact of the crisis on the estimation results, the crisis period is excluded from

the sample, and the regressions are re-estimated.

To define the time period of the financial crisis, this paper follows Nakamura and Steinsson (2018) who define the height of the financial crisis as given by the period July-2008 to June-2009. During this time period three repo rate decisions were announced. All three decisions implied large decreases of the repo rate, as is shown in Table A1 in Appendix. When these observations are excluded from the sample, the estimated effect of repo rate announcements on inflation expectations is positive and weakly significant, as is shown in the second column of Table 3. The complete regression results, including the OLS estimates, are shown in Table A3 in Appendix. The magnitude of the estimated coefficients are similar to the main result shown in the first column. Thus, the financial crisis does not appear to be driving the results.

Table 3: Robustness tests

| Variables: <i>dep. var</i> π^e | Main result | Excluding the financial crisis | Truncation of extreme values | | | Placebo test |
|------------------------------------|---------------------|--------------------------------|------------------------------|-----------------------------|-----------------------------|--------------------|
| | | | $50\% \leq \pi^e \leq -10\%$ | $30\% \leq \pi^e \leq -5\%$ | $20\% \leq \pi^e \leq -2\%$ | |
| Repo rate announcement | 0.465*** (0.154) | 0.514* (0.269) | 0.430*** (0.146) | 0.395*** (0.133) | 0.340*** (0.119) | - |
| After announcement dummy | 0.0957 (0.0608) | 0.113* (0.0621) | 0.0834 (0.0575) | 0.0734 (0.0526) | 0.0445 (0.0471) | 0.0184 (0.0436) |
| Period specific intercept | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Observations | 36,466 | 32,745 | 36,466 | 36,466 | 36,466 | 50,360 |

Note: standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5.2 Extreme Values

Survey responses are often suspected to contain errors or extreme observations, which in the case of inflation expectations may cause either positive or negative biases. However, the extent of erroneous and extreme observations is typically unknown. Research based on survey data therefore often uses methods for detecting and adjusting for extreme observations. However, two main issues arise. The first is how to decide on which observations that should be considered as extreme. Second, what should be done with these observations once they are identified (Curtin, 1996). There is no unique statistical method to identify extreme values and decide on their information content. Lacking any additional information which clarifies the information content, Curtin (1996) suggest handling extreme observations by re-weighting or truncating, e.g. using Winsorized means, rather than eliminating the observations.

Following Curtin (1996) and Pfajfar and Santoro (2010), two formulations of truncation of extreme values are considered. First, observations of expected inflation below -10% and above +50%, second, below -5% and above +30%. Values outside these bounds are truncated, i.e. replaced by the value the observations closest to them. In addition, a third alternative is considered where observations below -2% and above +20% are truncated. The regression results obtained using the adjusted samples are shown in columns 3-5 in Table 3. The complete regression results including the OLS estimates are

shown in Table A4 in Appendix.

The estimated coefficients are positive, significant and of similar magnitude using all three extreme value adjusted samples. The estimated coefficients are of slightly smaller magnitudes relative to the main result. In addition, the size of the coefficient decreases as the criteria of extreme value observations becomes narrower. At the same time, the standard error of the estimated coefficient obtained using the adjusted samples is smaller, indicating an increase in the precision of the estimated effect. Thus, extreme values does not appear to drive results.

5.3 Placebo Test

Even though the survey data are collected by random selection (conditional on fulfilling quotas for gender, age and geographical region of residence of the Swedish population) the households interviewed before a repo rate announcement may still systematically differ in characteristics compared to those interviewed after. The issue arises if households that enter the survey in the beginning differ in observable or unobservable ways, as compared to households that enter the survey late. Factors contributing to such differences may consist of observable, and in the sample measurable, characteristics such as employment status, income level and age. However, unobservable, or in the sample unmeasured, factors may be important contributors as well, such as socio-economic status, hours worked and occupation.

The presence of systematic compositional differences in the sample would imply that the estimated effect of repo rate announcements on inflation expectations may reflect these differences rather than the true effect of the announcements. To examine the possible presence of systematic differences, a placebo test is conducted. The idea of the placebo test is to examine whether the inflation expectations of households interviewed in the three day period prior a repo rate decision differ systematically from the inflation expectations collected in the three day period after. This is be done by utilizing observations of inflation expectations recorded in months where no repo rate announcements took place, using the corresponding six day sample window. A placebo test sample is constructed including only the months where no repo rate announcements took place. In these months, only observations of inflation expectations collected during the same interview dates as in the closest month with a the repo rate announcement(e.g. in the month before or after). Using the resulting sample, the following regression is estimated:

$$\pi_{i,j}^e = \alpha_j + \gamma D_{i,j} + \varepsilon_{i,j}, \quad (5)$$

where α_j is an intercept specific to period j , $D_{i,j}$ is a dummy variable that takes value one if household i is interviewed in the later of the two three day periods, and $\varepsilon_{i,j}$ is the error term. The placebo test indicates the presence of systematic differences if the estimated coefficient on the dummy variable, $D_{i,j}$, is significantly different from zero. The results are displayed in column 6 in Table 3. The complete regression results are shown in Table A5 in Appendix. As the estimated coefficient is not significant, the result does not indicate any evidence of systematic differences between households interviewed

before and after a repo rate announcement. This finding is consistent with the insignificant coefficient of the dummy variable D in the baseline estimation. Hence, compositional differences in the survey data are concluded to not drive the results.

6 Heterogeneity

Heterogeneity in households' inflation expectations is a common finding in the existing empirical literature on inflation expectations. In particular, the previous literature finds heterogeneity in inflation expectations based on several characteristics, such as age (e.g. Easterly and Fischer, 2001; Pfajfar and Santoro, 2010), life time experiences (e.g. Ehrmann and Tzamourani, 2012; Malmendier and Nagel, 2015), income level (e.g. Easterly and Fischer, 2001; Pfajfar and Santoro, 2010), education (e.g. Easterly and Fischer, 2001; Pfajfar and Santoro, 2010), gender (e.g. Jonung, 1981; Bryan et al., 2001) and occupation (e.g. Easterly and Fischer, 2001).

If heterogeneity is present also in the response of inflation expectations to monetary policy announcements, this implies that different household react differently to monetary policy actions. This, in turn, may have implications for how monetary policy announcements should be communicated efficiently to affect the inflation expectations of as many households as possible. To examine whether the observed heterogeneity in inflation expectations translates to the effect of monetary policy announcements on inflation expectations, households are grouped into sub-samples reflecting their demographic characteristics. The set of characteristics considered is based on the findings of the existing empirical literature on inflation expectations; gender, age, income level, and educational level.⁹

The regression model 4 is estimated for each sub-sample. The 2SLS estimation results are shown in Table 4. The first two columns of Panel (a) show that the estimated effect is positive and significant for both men and women. The magnitude is similar, as it is only slightly greater for women than for men.¹⁰ This result may also be interpreted in line with the findings of Coibion et al. (2019). They conduct randomized trials on US individuals to study how eight different forms of information regarding inflation affect inflation expectations. They find that most groups respond similarly to the information signals in their trials. However, women are found to respond more strongly than men to almost every information treatment.

The following five columns in Panel (a) show the results for sub-sample groups based on the age of the respondent. The estimated effect of repo rate announcements on inflation expectations is only statistically significant for respondents belonging to the middle aged group, 35-49. Albeit not

⁹In the survey data sample, the of the survey respondents is divided into five groups; (i) 16-24, (ii) 25-34, (iii) 35-49, (iv) 50-64, (v) 65. The income level is divided into four groups based on annual earnings (Swedish Kronor); (i) 0-210 000, (ii) 210 001-365 000, (iii) 365 001-621 000, (iv) 621 001+. The education level is divided into three groups; (i) Primary education, (ii) Secondary education, (iii) Further education.

¹⁰Previous research typically finds that women on average expect a higher rate of inflation than men, (see e.g. Jonung, 1981) and Bryan et al. (2001)

statistically significant and estimated with less precision, the youngest age group stands out with an magnitude of the estimated effect that is larger than one. However, even more striking is the estimate for the respondents of age 50-64, for which the estimated effect is close to zero in magnitude.

Next, the households are separated based on their income levels and the estimation results are shown in the first four columns in panel (b). The estimated effect of repo rate announcements on inflation expectations is only significant for households in the two middle income level groups. While estimated with less precision for the lowest income group, the estimated effect is close in magnitude to those of the two middle income group. The highest income group stands out as the estimated effect of a policy rate announcement, albeit not statistically significant, is negative sign and close to zero in magnitude. Somewhat in line with this result, Coibion et al. (2019) find that middle income respondents (\$40,000 - \$100,000) respond more to information treatments compared to both lower and higher income respondents.

Table 4: Heterogeneity

| <i>dep. var:</i> π^e | Gender | | Age | | | | |
|---------------------------|--------------------|--------------------|---------------------|-------------------|--------------------|-------------------|------------------|
| Panel (a) | Men | Women | 16-24 | 25-34 | 35-49 | 50-64 | 65+ |
| Repo rate announcement | 0.378** (0.182) | 0.542** (0.253) | 1.302 (0.892) | 0.640 (0.447) | 0.707** (0.281) | 0.004 (0.249) | 0.265 (0.285) |
| After announcement dummy | 0.042 (0.074) | 0.148 (0.098) | 0.708*** (0.251) | 0.303* (0.155) | -0.0699 (0.119) | 0.0439 (0.104) | 0.073 (0.123) |
| Period specific intercept | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Observations | 18,786 | 17,680 | 4,351 | 5,914 | 9,741 | 9,269 | 7,191 |

| Panel (b) | Income | | | | Education | | |
|---------------------------|--------------------|-------------------|--------------------|-------------------|-------------------|---------------------|------------------|
| | Low | Low-Mid | Mid-high | High | Prim | Second | Further |
| Repo rate announcement | 0.595 (0.639) | 0.742* (0.395) | 0.723** (0.300) | -0.079 (0.183) | -0.126 (0.499) | 1.144*** (0.265) | 0.103 (0.187) |
| After announcement dummy | 0.503** (0.202) | -0.092 (0.145) | -0.036 (0.110) | 0.080 (0.085) | 0.209 (0.197) | 0.120 (0.101) | 0.043 (0.076) |
| Period specific intercept | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Observations | 4,886 | 6,779 | 8,373 | 10,986 | 4,989 | 15,029 | 16,375 |

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Lastly, households are separated based on educational level, and the results are shown in columns five to seven in panel (b). A significant and sizeable effect of repo rate announcements on inflation expectations is detected for respondents with secondary education. The effect estimated for respondents with a lower or higher educational degree is not found significant and are smaller in magnitude. In contrast, Coibion et al. (2019) find little heterogeneity in how US respondents change their beliefs in response to new information based both on their age and education.

The group specific estimates are largely in line with the positive sign found for the effect in the baseline results. However, the effect is not found significant for all the different groups and the magnitudes

of the estimated effect also differ across groups, suggesting that some groups may be more responsive to the Riksbank's policy rate announcements. In particular, the inflation expectations of the middle aged (35-49), those belonging to the middle income groups, and those with secondary education, have significant positive responses of a relatively large magnitude to policy rate announcements. While the effect of policy rate announcements on the inflation expectations of slightly older respondents (50-64), and respondents belonging to the highest income group is close to zero in magnitude.

These results suggest that heterogeneity is not only present in the levels of household inflation expectations, but also in the effect of monetary policy announcements on household inflation expectations. Furthermore, the above results may suggest that households with stronger incentives keep track of policy rate announcements, e.g. low and middle income households at the beginning or middle of their career with mortgages, change their inflation expectations in response to a monetary policy announcement while with less incentive do so to a lesser extent, i.e. households that are still in their working age (50-64) but with high income and no mortgage payments. The positive sign of the effect of the former group may be reflecting the effect of revealed private information of the central bank, or as households internalizing the direct effect of the mortgage interest rates on CPI inflation.

7 Conclusion

Inflation expectations affect inflation outcomes as well as economic activity, via firms' price setting decisions and the wage demands posed by unions and workers. Inflation expectations are an important part of the transmission channel through which the central bank's monetary policy actions affect the economy. This paper empirically examines the effect of monetary policy announcements on households' inflation expectations, using monthly survey data of Swedish households' inflation expectations collected during a three day time window before and after 29 policy rate announcements of the Swedish central bank during the time period 2003-2015. As households may change their expectations in anticipation of an announcement, an instrumental variable approach is used. The announcements are instrumented by a monetary policy surprise variable obtained from high-frequency swap trade data.

The empirical results indicate that an increase of the policy rate has a significantly positive effect on inflation expectations. This result is not in line with the prediction of the classical New-Keynesian model. Under the assumption of a moderately persistent shock process, as in Galí (2015), the New-Keynesian model predicts a negative relationship between the central bank's policy rate and inflation expectations. However, if the monetary policy shock process is assumed to be highly persistent, the model instead predicts a positive relationship. In this case, the empirical results may be interpreted to be in line with the theoretical prediction.

Alternatively, an unexpected change in the policy rate may be endogenous if the announcement reveals the central bank's private information on the state of the economy. The results may be interpreted

as an unexpected increase in the policy rate revealing information that the Riksbank expects inflation to increase in the future, leading households to increase their inflation expectations as well. A third interpretation of the results is related to the sizeable weight placed on housing interest costs in the Swedish CPI basket (about 6% in 2014). This effect will cause the CPI will increase as the policy rate increases. The results may be interpreted as households internalizing the direct effect of a repo rate change on the housing interest rate costs into their inflation expectations. However, to completely understand the relationship between interest rates on inflation expectations complimentary research is needed, especially considering longer time horizons for expectations.

Robustness checks suggest that the main result is neither driven by the presence of extreme value observations nor the occurrence of the financial crisis in 2008/2009. In addition, a placebo test is conducted to examine the possible presence of systematic differences between households, which may affect the results. No evidence of systematic differences is found.

Heterogeneity across different groups of households in the effect of an unexpected change in the policy rate on inflation expectations is considered. Heterogeneity in the effect of monetary policy announcements across households may indicate whether different types of household respond differently to monetary policy. In a broader sense, heterogeneity may have implications for how central banks efficiently communicate their announcements to the general public. The sign of the estimated effect is largely homogeneous across different groups based on the demographic characteristics of households. However, the effect is not significant for all groups and magnitude of the estimated effect differ across groups, suggesting that the effect of monetary policy announcements on inflation expectations differ across households. In particular, the effect appears to be stronger on those of age 35-49, in low or middle income levels, or with a secondary education. These results may suggest that the households that are affected the most by policy rate changes, e.g. due to sizeable mortgages, also respond the most to announced changes.

References

- Amstad, M. and Fischer, A. M. (2009). Do macroeconomic announcements move inflation forecasts? *Federal Reserve Bank of St. Louis Review*, 91(September/October 2009).
- Andersson, M., Dillen, H., and Sellin, P. (2006). Monetary policy signaling and movements in the term structure of interest rates. *Journal of Monetary Economics*, 53(8):1815–1855.
- Archer, D. (2005). Central bank communication and the publication of interest rate projections. In *a conference on Inflation Targeting: Implementation, Communication and Effectiveness, Sveriges Riksbank, Stockholm, June*, pages 10–12.
- Barakchian, S. M. and Crowe, C. (2013). Monetary policy matters: Evidence from new shocks data. *Journal of Monetary Economics*, 60(8):950–966.
- Binder, C. (2017). Fed speak on main street: Central bank communication and household expectations. *Journal of Macroeconomics*, 52:238–251.
- Blinder, A. S., Ehrmann, M., Fratzscher, M., De Haan, J., and Jansen, D.-J. (2008). Central bank communication and monetary policy: A survey of theory and evidence. *Journal of Economic Literature*, 46(4):910–45.
- Brubakk, L., Ter Ellen, S., and Xu, H. (2017). Forward guidance through interest rate projections: does it work?
- Bryan, M. F., Venkatu, G., et al. (2001). *The curiously different inflation perspectives of men and women*. Federal Reserve Bank of Cleveland, Research Department.
- Calvo, G. (1983). Staggered prices in a utility-maximizing framework. *Journal of Monetary Economics*, 12(3):383–398.
- Campbell, J. R., Evans, C. L., Fisher, J. D., Justiniano, A., Calomiris, C. W., and Woodford, M. (2012). Macroeconomic effects of federal reserve forward guidance [with comments and discussion]. *Brookings Papers on Economic Activity*, pages 1–80.
- Carroll, C. D. (2003). Macroeconomic expectations of households and professional forecasters. *the Quarterly Journal of economics*, 118(1):269–298.
- Christiano, L. J., Eichenbaum, M., and Evans, C. L. (1999). Monetary policy shocks: What have we learned and to what end? *Handbook of macroeconomics*, 1:65–148.
- Coibion, O. and Gorodnichenko, Y. (2015). Information rigidity and the expectations formation process: A simple framework and new facts. *American Economic Review*, 105(8):2644–78.
- Coibion, O., Gorodnichenko, Y., and Weber, M. (2019). Monetary policy communications and their effects on household inflation expectations. Technical report, National Bureau of Economic Research.

- Curtin, R. (1996). Procedure to estimate price expectations. *Manuscript, University of Michigan Survey Research Center*.
- Dräger, L. (2015). Inflation perceptions and expectations in sweden—are media reports the missing link? *Oxford Bulletin of Economics and Statistics*, 77(5):681–700.
- Dräger, L., Lamla, M. J., and Pfajfar, D. (2016). Are survey expectations theory-consistent? the role of central bank communication and news. *European Economic Review*, 85:84–111.
- Easterly, W. and Fischer, S. (2001). Inflation and the poor. *Journal of Money, Credit and Banking*, pages 160–178.
- Ehrmann, M. and Tzamourani, P. (2012). Memories of high inflation. *European Journal of Political Economy*, 28(2):174–191.
- Eichengreen, B. and Dincer, N. (2010). Central bank transparency: causes, consequences and updates.
- Ellingsen, T. and Söderström, U. (2001). Monetary policy and market interest rates. *American Economic Review*, 91(5):1594–1607.
- Galí, J. (2015). *Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework and Its Applications Second edition*. Princeton University Press, 2 edition.
- Gertler, M. and Karadi, P. (2015). Monetary policy surprises, credit costs, and economic activity. *American Economic Journal: Macroeconomics*, 7(1):44–76.
- Goodhart, C. A. (2001). Monetary transmission lags and the formulation of the policy decision on interest rates. In *Challenges for Central Banking*, pages 205–228. Springer.
- Gürkaynak, R. S., Sack, B., and Swanson, E. (2005). The sensitivity of long-term interest rates to economic news: Evidence and implications for macroeconomic models. *American economic review*, 95(1):425–436.
- Hallsten, K. and Tägtström, S. (2009). The decision-making process—how the executive board of the riksbank decides on the repo rate. *Sveriges Riksbank Economic Review*, 2009:1–69.
- Hamilton, J. D. (2008). Daily monetary policy shocks and new home sales. *Journal of Monetary Economics*, 55(7):1171–1190.
- Jonung, L. (1981). Perceived and expected rates of inflation in sweden. *The American Economic Review*, 71(5):961–968.
- Kuttner, K. N. (2001). Monetary policy surprises and interest rates: Evidence from the fed funds futures market. *Journal of monetary economics*, 47(3):523–544.
- Malmendier, U. and Nagel, S. (2015). Learning from inflation experiences. *The Quarterly Journal of Economics*, 131(1):53–87.
- Nakamura, E. and Steinsson, J. (2018). High-frequency identification of monetary non-neutrality: the information effect. *The Quarterly Journal of Economics*, 133(3):1283–1330.

- Pfajfar, D. and Santoro, E. (2010). Heterogeneity, learning and information stickiness in inflation expectations. *Journal of Economic Behavior & Organization*, 75(3):426–444.
- Ramey, V. A. (2016). Macroeconomic shocks and their propagation. In *Handbook of Macroeconomics*, volume 2, pages 71–162. Elsevier.
- Sandström, M. (2018). The impact of monetary policy on household borrowing - a high-frequency iv identification. Technical report, Sveriges Riksbank Working Paper Series 351.
- Stock, J. and Yogo, M. (2005). *Testing for Weak Instruments in Linear IV Regression*, pages 80–108. Cambridge University Press, New York.
- Stock, J. H., Wright, J. H., and Yogo, M. (2002). A survey of weak instruments and weak identification in generalized method of moments. *Journal of Business & Economic Statistics*, 20(4):518–529.
- Szyszkowski, M. (2015). Inflation forecasts versus shaping inflation expectations. comparative analysis/prognoza inflacji wobec kształtowania oczekiwań inflacyjnych. analiza porównawcza. *Comparative Economic Research*, 18(4):139–156.
- Van der Cruijsen, C., Jansen, D.-J., De Haan, J., et al. (2015). How much does the public know about the ecb’s monetary policy? evidence from a survey of dutch households. *International Journal of Central Banking*, 11(4):169–218.

Appendices

Table A1: Repo rate announcements

| Announcement day | Monetary policy surprise | Repo rate | Change of repo rate announcement |
|------------------|--------------------------|-----------|----------------------------------|
| 6/5/2003 | -0.0900 | -0.50 | Decreased by 0.50 points |
| 8/15/2003 | -0.0214 | 0.00 | Unchanged |
| 10/16/2003 | 0.0000 | 0.00 | Unchanged |
| 12/5/2003 | 0.0214 | 0.00 | Decreased by 0.25 points |
| 2/6/2004 | 0.0200 | -0.25 | Unchanged |
| 12/9/2004 | 0.0000 | 0.00 | Unchanged |
| 12/2/2005 | -0.0107 | 0.00 | Unchanged |
| 5/4/2007 | -0.0641 | 0.00 | Unchanged |
| 9/7/2007 | 0.0232 | 0.25 | Increased by 0.25 points |
| 2/13/2008 | 0.1760 | 0.25 | Increased by 0.25 points |
| 9/4/2008 | 0.0963 | 0.25 | Unchanged |
| 10/8/2008 | -0.3954 | -0.50 | Decreased by 0.50 points |
| 12/4/2008 | -0.4246 | -1.75 | Decreased by 1.75 points |
| 2/11/2009 | -0.2346 | -1.00 | Decreased by 1.00 points |
| 9/3/2009 | -0.0111 | 0.00 | Unchanged |
| 2/11/2010 | 0.0000 | 0.00 | Unchanged |
| 9/2/2010 | 0.0185 | 0.25 | Increased by 0.25 points |
| 7/5/2011 | 0.0126 | 0.25 | Increased by 0.25 points |
| 9/7/2011 | 0.0248 | 0.00 | Unchanged |
| 7/4/2012 | 0.0682 | 0.00 | Unchanged |
| 9/6/2012 | -0.1610 | -0.25 | Decreased by 0.25 points |
| 7/3/2013 | 0.0186 | 0.00 | Unchanged |
| 9/5/2013 | 0.0000 | 0.00 | Unchanged |
| 4/9/2014 | 0.0434 | 0.00 | Unchanged |
| 7/3/2014 | -0.2645 | -0.5 | Decreased by 0.50 points |
| 9/4/2014 | 0.0189 | 0.00 | Unchanged |
| 2/12/2015 | -0.0408 | -0.10 | Decreased by 0.10 points |

Table A2: Summary statistics

| | π^e | Repo rate | Monetary policy surprise |
|--------------------|---------|-----------|--------------------------|
| Mean | 2.345 | -0.116 | -0.039 |
| Standard deviation | 4.694 | 0.420 | 0.135 |
| N | 229500 | 29 | 29 |

Table A3: Excluding the financial crisis (06-2008 - 07-2009)

| Variables: | OLS | | | 2SLS | | |
|---------------------------|---------------------|----------------------|--------------------|---------------------|---------------------|--------------------|
| | <i>dep. var</i> | π^e | | <i>dep. var</i> | π^e | |
| Repo rate announcement | 1.210*** (0.138) | 1.204*** (0.141) | 0.398* (0.215) | 1.500*** (0.179) | 1.507*** (0.184) | 0.514* (0.269) |
| After announcement dummy | - | -0.00924 (0.0374) | 0.105* (0.0611) | - | 0.00592 (0.0379) | 0.113* (0.0621) |
| Period specific intercept | - | - | ✓ | - | - | ✓ |
| Observations | 32,745 | 32,745 | 32,745 | 32,745 | 32,745 | 32,745 |

Note: standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A4: Outlier adjusted sample

| Variables: | OLS | | | 2SLS | | |
|--|----------------------|----------------------|--------------------|----------------------|----------------------|---------------------|
| | <i>dep. var</i> | π^e | | <i>dep. var</i> | π^e | |
| (a) Truncation of observations below -10% and above +50% | | | | | | |
| Repo rate announcement | 0.605*** (0.0683) | 0.626*** (0.0708) | 0.257** (0.123) | 0.586*** (0.0784) | 0.612*** (0.0824) | 0.430*** (0.146) |
| After announcement dummy | - | 0.0367 (0.0338) | 0.0581 (0.0564) | - | 0.0350 (0.0343) | 0.0834 (0.0575) |
| (b) Truncation of observations below -5% and above +30% | | | | | | |
| Repo rate announcement | 0.534*** (0.0623) | 0.553*** (0.0647) | 0.232** (0.112) | 0.516*** (0.0716) | 0.540*** (0.0752) | 0.395*** (0.133) |
| After announcement dummy | - | 0.0330 (0.0309) | 0.0496 (0.0515) | - | 0.0314 (0.0313) | 0.0734 (0.0526) |
| (c) Truncation of observations below -2% and above +20% | | | | | | |
| Repo rate announcement | 0.422*** (0.0559) | 0.433*** (0.0580) | 0.207** (0.101) | 0.408*** (0.0642) | 0.422*** (0.0674) | 0.340*** (0.119) |
| After announcement dummy | - | 0.0193 (0.0277) | 0.0251 (0.0462) | - | 0.0179 (0.0280) | 0.0445 (0.0471) |
| Period specific intercept | - | - | √ | - | - | √ |
| Observations | 36,466 | 36,466 | 36,466 | 36,466 | 36,466 | 36,466 |

Note: standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A5: Placebo test

| Variables: | <i>dep. var:</i> | π^e |
|---------------------------|--------------------|----------------------|
| After announcement dummy | 0.0345 (0.0423) | 0.0184 (0.0436) |
| Period specific intercept | - | $\sqrt{}$ |
| R-squared | 0.000 | 0.032 |
| Observations | 50,360 | 50,360 |

Note: standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1