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Monetary Policy Surprises, Central Bank Information Shocks, and Economic Activity in a Small Open Economy[1]

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Abstract

In this paper I study the effects of monetary policy on economic activity and asset prices in Sweden, separately identifying the effects of a conventional policy change from effects of new information about economic fundamentals. Recent research has shown that high-frequency changes in policy interest rate futures prices around central bank policy announcements might not only contain monetary policy shocks but also central bank information shocks. I add to this line of research by studying a case where the central bank, in contrast to many other central banks studied in this literature, is very open and transparent about the monetary policy decision and publishes a full set of forecasts including the interest rate at the same moment as the decision is revealed. I use this information to construct an informationally-robust instrument for monetary policy shocks as the component of high-frequency market surprises triggered by policy announcements that is orthogonal to both central bank's economic projections, including policy rate projections, and to past market surprises. I also add sign restrictions on stock market changes around the announcement to separate structural monetary policy shock from central bank information shocks. In contrast to recent work for other countries, I do not find that separating monetary policy shocks from central bank information shocks is important to measure the effects of monetary policy in Sweden.

JEL-codes: C32, C36, D83, E31, E43, E44, E52, E58, G14
Keywords: Monetary Policy, External Instruments, Monetary Policy Surprises, Information Effect, Small Open Economy, Exchange Rate, Stock Prices, House Prices.

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1. Introduction

Quantifying the effects of monetary policy is one of the most enduring questions in macroeconomics and the identification of monetary policy shocks has generated a vast literature in empirical macroeconomics. The crucial empirical challenge in answering this question is that most changes in interest rates happen for good reason. For example, the central bank might lower interest rates to counteract the effects of an adverse shock to aggregate demand. In this case, the effect of the central bank's actions are confounded by the shock. This makes it difficult to separate the regular response of policy to the economy from the response of the economy to policy. A recent major innovation in the empirical literature on the dynamic causal inference of monetary policy in this regard has been the adoption of external instruments. [3] These instruments provide direct measures of the structural policy disturbances, e.g. the narrative instrument proposed by Romer and Romer (2004), or the market surprises of Kuttner (2001). The latter measure hinges on the sporadic way monetary news is revealed which allows for a discontinuity-based identification scheme. There is however an empirical finding which suggests that the interpretation of shocks derived from this discontinuity-based identification scheme might be confounded by other shocks. A recent literature document that in response to an unexpected increase in the real interest rate (a monetary tightening), survey estimates of expected output growth rise while those of inflation decline (e.g. Campbell et al., 2012 and Nakamura and Steinsson 2018). This finding is clearly in the opposite direction from what one would expect from the conventional interpretation of monetary shocks. An explanation for this puzzling fact is the existence of the so-called "central bank information channel". [4] According to the information channel, agents update their beliefs after an unexpected monetary policy announcement not only because they learn about the current and future path of monetary policy, but also because they learn new information about economic fundamentals. The information channel is clearly more plausible if central banks are more informed about the state of the economy relative to market participants and should depend on the degree of central bank transparency. Central bank transparency is specifically seen as a way of enabling markets to respond more smoothly to policy decisions. When a central bank is more transparent about its economic outlook and about how that outlook is related to its policy stance, monetary policy decisions are less likely to come as a surprise. Investors are less likely to be

[3] An external instrument is a variable that is correlated with a shock of interest, but not with other shocks, so that the instrument captures some exogenous variation in the shock of interest. Using monetary policy surprises measured in daily or higher frequency as instruments one can study asset price responses to monetary policy in a meaningful way (Altavilla et al. 2020). The identifying assumption is that monetary policy does not respond to asset price changes within the day, hence causality goes from monetary policy to asset prices.

[4] The idea that monetary policy announcements affect agents' beliefs about economic fundamentals, and not only about monetary policy, has also been proposed by Ellingsen and Söderström (2001).

caught unawares by policy actions. Thus far a central bank information effect has been documented in the United States (Federal Reserve) and in the Euro zone (European Central Bank). Studies of more open and transparent central banks are thus far missing.

In this paper I address two questions. First, what is the nature and magnitude of the transmission mechanism is in Sweden and second, and possibly of broader interest, are central bank information shocks also a pervasive feature of market surprises in the case where the central bank is highly transparent an reveals a large amount of information and reasoning regarding the interest rate decision?

To answer the first question I use the relatively recent innovation in dynamic causal inference namely "external instruments" in vector autoregressions (Stock and Watson 2012 and 2018, Mertens and Ravn 2013) to estimate the causal effects of exogenous monetary shocks on output, inflation, the exchange rate and financial conditions.

To answer the second question I use a two-pronged approach to account for the possible presence of information frictions in the Riksbank (the central bank of Sweden) monetary policy announcements. The first approach follows Jarociński and Karadi (2020) and separates monetary policy shocks from contemporaneous information shocks by analyzing the high-frequency co-movement of interest rates and stock prices around the policy announcement. This co-movement is informative because standard theory has clear predictions on its direction after a policy change. A pure monetary policy tightening shock leads to lower stock market valuation in a broad range of models.[5] Hence, in this approach I use market prices to learn the content of the signal inherent in central bank announcements. The second route in accounting for the possible presence of information frictions follows Miranda-Agrippino and Ricco (2020), who in turn build on Romer and Romer (2000), and define monetary policy shocks as shifts to the policy rate that are both unforeseen by market participants, and are not due to the central bank's concerns about either current or anticipated changes in economic conditions.[6] What is novel in the way I implement this approach is not the method to control for the central bank's private information but the information that is being controlled for. Previous studies have not been able to control for a complete set of real time forecasts including policy rate projections that accompany each policy announcement. Moreover, the forecasting horizon is relatively short in previous studies and are staff forecasts. Greenbook forecasts

[5] The present value of future dividends declines because the discount rate increases and the expected dividends decline with the deteriorating outlook caused by the policy tightening.
[6] See also Barakchian and Crowe (2013), Campbell et al. (2016) and Lakdawala (2019) for comparable approaches on U.S. data.

are e.g. only available for a few quarters ahead (see e.g. Miranda-Agrippino and Ricco 2020). I use the Riksbank executive board's (comparable to the FOMC) own forecasts for up to three years to compute an informationally-robust instrument at regular and scheduled monetary policy announcements. Accounting for longer run forecasts over the whole policy horizon is important if policymakers e.g. react to an expected increase in inflation further out than a few quarters by tightening monetary policy to partially offset it. Then a monetary contraction will appear to cause higher inflation if these anticipatory movements are not explicitly allowed for. I control for the entire forecast horizon of the central bank of three years.

Regarding the first question I find that a tightening of monetary policy (accounting for information shocks) has significant effects on the real economy, raising unemployment and depressing economic activity, as well as appreciating the domestic currency and inducing a reduction in the consumer price index excluding energy (CPIF-XE) and tighter financial conditions. In an extended and more granular analysis I find that a monetary policy tightening leads to an increase of mortgage bond spreads, leading to a contraction in total credit and a fall in real house prices. I also find a significant and clear liquidity effect – an increase in nominal interest rates is accompanied by a monetary contraction (M1 jumps downward). I show that MFI lending rates to households are more responsive than deposit rates. These impulse responses provide support to the view that monetary policy reduces the net worth and liquidity of borrowers which increases the effective cost of credit by more than the change in risk-free rates, thus intensifying the effect of the policy action.

I find that central bank information shocks do not bias the standard high-frequency identification of monetary policy shocks in the Swedish case. Both approaches to account for the possible presence of information frictions in Riksbank monetary policy announcements yield very similar results. There are small differences between monetary policy shocks and information shocks which is contrary to what is found by Jarociński and Karadi (2020) for the U.S. and the Euro area and by Miranda-Agrippino and Ricco (2020) for the U.S. Hence, the lack of a clear information channel could be related to, or is at least not inconsistent with, the transparency and communication strategies implemented by Sveriges Riksbank. The Riksbank is one of the most transparent central banks in the world and the public has had access to a full set of forecasts, including the policy interest rate, for almost fifteen years. Interestingly, Hoesch et al. (2020) investigate how the Fed's monetary policy information content has evolved over time and show that, in the last decade, the central bank lost its informational advantage. Their results might be linked to several factors – including an improvement in the Fed's communication and transparency.

Related literature. My paper contributes to two interrelated lines of research. First, I contribute to the line of research that assesses the impact of high-frequency financial-market surprises around key monetary policy announcements on asset prices (Kuttner 2001, Faust et al. 2003, Gürkaynak et al. 2005a and 2005b, Bernanke and Kuttner 2005, Barakchian and Crowe 2013) and the macroeconomy (Faust et al. 2004, Campbell et al. 2012, Gertler and Karadi 2015, Paul 2017, Nakamura and Steinsson 2018, Jarociński and Karadi 2020). Only a few papers have empirically investigated the transmission mechanism in the case of Sweden. These are for example Adolfson et al. (2007), Bjørnland (2008, 2009), Jacobson et al. (2002) Lindé et al. (2009), Villani and Warne (2003) and Björklund et al. (2019) who all use VARs (Bayesian and frequentist) with internal instruments, i.e. the instruments are obtained from restrictions on the VAR system. An exception is Sandström (2018) who uses a local projection (Jorda 2005) on quarterly data to study the effects of monetary policy on household debt. A few papers study how Swedish interest rates responds in the immediate aftermath of Riksbank announcements. See e.g. Andersson et al. (2006), Fransson and Tysklind (2016), De Rezende (2017) and Iversen and Tysklind (2017). There have been other studies in this area based on fully interpreted structural dynamic stochastic general equilibrium models, which have included estimated effects of monetary policy. These DSGE models, though, have imposed more identifying restrictions than I impose here. See e.g. Adolfson et al. (2008).

Second, I contribute to the empirical research that assesses the extent of information asymmetry about the economy between the central bank and the public. Romer and Romer (2000) presents evidence that the Federal Reserve Board (FRB) staff processes publicly available information more effectively than the public when forming forecasts. Other related papers include Cieslak and Schrimpf (2019), Jarociński and Karadi (2020) and Miranda-Agrippino and Ricco (2020). Hoesch et al. (2020) explores the empirical importance of the information channel of U.S. monetary policy and how it changed over time. Bauer and Swanson (2020) show that the empirical results which the above papers interpret as an "information channel" are more consistent with a "Fed response to news" channel, in which incoming, publicly available economic news causes both the Fed to change monetary policy and the private sector to revise its forecasts. They provide evidence that distinguishes between these two channels which favors the latter.

The remainder of this paper is structured as follows. Section 2 describes the econometric framework and the identification strategy regarding the sign-restrictions. Section 3 describes the data, the computation of the information-robust instrument and the estimation results. Section 4 concludes.

2. The econometric approach

The econometric model I use is a monthly structural vector autoregression (SVAR) with a mixture of economic and financial variables. To identify monetary policy surprises I use external instruments and, more specifically, the exogenous variable (frequentist) approach suggested by Paul (2020) and the combined sign-restrictions and external instrument (Bayesian) approach by Jarociński and Karadi (2020). The sign-restrictions are implemented using a Bayesian VAR following Arias et al. (2018). The reason for also using a Bayesian VAR is because it naturally handles set identification due to sign-restrictions. The use of external instruments in a VAR is a variation of the methodology developed by Stock and Watson (2012), Mertens and Ravn (2013) and applied to monetary policy surprises in the case of the United States by e.g. Gertler and Karadi (2015). I describe the general approach below.

The general structural form of the VAR I am using is given by

$$HY_t = A_0 + A_1 Y_{t-1} + \cdots + A_j Y_{t-j} + AZ_t + \varepsilon_t, \quad (1)$$

where Y_t is a $n \times 1$ vector of observable economic and financial variables. H and A_m $\forall m \geq 0$ are conformable coefficient matrices. Z_t is a vector of exogenous variables and A is a conformable coefficient matrix and ε_t is a vector of structural white noise shocks. Multiplying each side of the equation by H^{-1} yields the reduced-form representation

$$Y_t = B_0 + B_1 Y_{t-1} + \cdots + B_j Y_{t-j} + BZ_t + u_t, \quad (2)$$

where u_t is the reduced form shock, given by the following function of the structural shocks:

$$u_t = S\varepsilon_t, \quad (3)$$

with $B_m = H^{-1}A_m$ $\forall m \geq 0$, $B = H^{-1}A$ and $S = H^{-1}$. The econometric problem in identifying impulse responses is that the structural shocks ε_t are most often not observed. In this paper I am interested in the identification of impulse responses to a structural monetary policy shock, denoted by ε_t^{mp}. Accordingly, equation (3) can be rewritten as

$$u_t = s\varepsilon_t^{mp} + \underline{S}\varepsilon_{2:n,t}, \quad (4)$$

where s is the impulse vector associated with ε_t^{mp} and the $(n-1) \times 1$ vector $\varepsilon_{2:n,t}$ collects all other structural shocks. The idea of the external identification approach is to bring in information from external sources to identify the effects of structural shocks. In particular, assume that a proxy z_t for the latent shock of interest ε_t^{mp} exists and that z_t satisfies the following conditions

$$E\left[z_t \varepsilon_t^{mp}\right] = \varphi \neq 0, \tag{5}$$

$$E\left[z_t \varepsilon_{2:n,t}\right] = 0. \tag{6}$$

The external instrument approach can treat the proxy z_t either as instrumental variables or as directly observed (see Stock and Watson 2018). Here I follow Paul (2020) and Jarociński and Karadi (2020) and treat the proxy as directly observable. Paul's approach is to integrate z_t directly into (2) as an exogenous variable, i.e.

$$Z_t = z_t. \tag{7}$$

Paul shows analytically that this approach consistently identifies the true impulse responses even when the surprises contain measurement error that is orthogonal to all other variables or random zero observations.

As was discussed above, recent research has shown that high frequency monetary policy surprises should not be taken as direct observations of monetary policy shocks. One concern is that the surprises may be confounded by a release of a central bank's private information (Romer and Romer 2000, Melosi 2017). For example, Nakamura and Steinsson (2018) show that, for the case of the United States, private forecasters increase their expectations of output growth after unexpected increases in policy rates, the opposite of what standard models predict.

Jarociński and Karadi (2020) show that a simple way to separate monetary policy shocks from central bank information shocks is to add additional sign-restrictions on the monetary policy surprises. A convenient way to do this is to integrate z_t directly into (2) as an observable endogenous variable, i.e. by setting one of the variables in Y_t as

$$Y_{1,t} = z_t. \tag{8}$$

The remaining endogenous variables are collected in $Y_{2:n,t}$. Thus, the advantage of Jarociński and Karadi's approach is that sign restrictions can easily be applied to the VAR to separate monetary policy shocks from monetary policy information shocks.

In the Jarociński and Karadi approach, the expressions for $Y_{1,t}$ and $Y_{2:n,t}$ combine to yield the VAR[7]:

$$\begin{pmatrix} Y_{1,t} \\ Y_{2:n,t} \end{pmatrix} = \begin{pmatrix} 0 \\ B_{2:n}^{0} \end{pmatrix} + \sum_{i=1}^{p} \begin{pmatrix} 0 & 0 \\ B_{Y_1 Y_{2:n}}^{i} & B_{Y_{2:n} Y_{2:n}}^{i} \end{pmatrix} \begin{pmatrix} Y_{1,t-i} \\ Y_{2:n,t-i} \end{pmatrix} + BZ_t + u_t. \quad (9)$$

To control for unexpected changes in monetary policy due to central bank private information, I identify one standard monetary policy shock and one central bank information shock, which could both simultaneously be transmitted through the central bank announcements. I use two sign restrictions on the announcement surprises to isolate these shocks. I let $Y_{N_m+1:n,t}$ be a vector of N_y macroeconomic and financial variables observed in month t, and $Y_{1:N_m,t}$ a vector of surprises in N_m financial instruments observed in month t. The difference from (9) is that here I add an additional financial variable surprise to the first block of variables, so $N_m = 2$. To construct $Y_{1:N_m,t}$ I add up the intra-day surprises of Overnight Index Swaps (OIS) denominated in SEK occurring in month t on the days when Riksbank's Executive Board made monetary policy announcements as well as daily changes in the Nasdaq OMX Stockholm all-share index. $Y_{1:N_m,t}$ is zero in the months with no monetary policy announcements. No restrictions are imposed on any of the monthly macroeconomic and financial variables in $Y_{N_m+1:n,t}$. Table 1 summarizes the identifying restrictions.

Table 1. Identifying restrictions in the baseline VAR model

Variable	Monetary Policy (Negative co-movement)	CB information (Positive co-movement)	Other
$Y_{1:N_m,t}$, high frequency			
OIS Swap Rate	+	+	**0**
OMX Stock Index	-	+	**0**
$Y_{N_m+1:n,t}$, low frequency	•	•	•

Note: Restrictions are on contemporaneous responses of variables to shocks. •, **0**, + and – denote the unrestricted responses, zero restrictions and respective sign restrictions.

[7] I use a standard Bayesian prior for the VAR parameters, following Litterman (1986) and generate draws from the posterior using the Gibbs sampler.

The restrictions divide each month's announcement surprise into a monetary policy shock component and a central bank information shock component.

The idea behind the assumptions is that a monetary policy tightening implies a decline in stock prices in most models. A monetary tightening generates an economic contraction that reduces the expected value of future dividends, and the higher interest rates raise the discount rate with which these dividends are discounted. As a result, stock prices, which in the standard asset pricing theory are the present discounted value of future dividends, declines. Therefore, the negative co-movement shock is consistent with news being revealed about monetary policy. A positive co-movement reflects something in the central bank's announcement that is not news about monetary policy.[8]

3. Data, Estimation, and Results

I begin this section by providing further details on the data I use in the VAR’s. In this section I also describe how I construct the informationally-robust instrument.

I use monthly data for the Swedish economy. The estimation sample is January 2000 to December 2019. The main reason for not using a longer sample is that the measure of monetary policy surprises starts in 2003. $Y_{1:N_m,t}$ consists of the surprises in the overnight index swaps (OIS) denominated in SEK and the daily change in the OMX All-Share Stockholm stock market index.[9] $Y_{N_m+1:n,t}$ includes the 3-month Stockholm Interbank Offered Rate (Stibor), the trade-weighted nominal exchange rate (defined as SEK per foreign currency which implies that an appreciation of the Krona is a negative response in the figures below), consumer price (CPIF-XE) index excluding energy prices, real gross domestic product (GDP) and a broad financial conditions index (See Alsterlind et al. 2020). A financial conditions index (FCI) summarizes the information about the future state of the economy contained in current financial variables.

I interpolate real GDP to monthly frequency following Bernanke et al. (1997). This method uses a Kalman filter to distribute the quarterly series across months using a dataset of monthly variables that are closely related to economic activity. The exchange rate, CPIF-XE inflation and the monthly GDP

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[8] An alternative strategy would be to follow Ellingsen and Söderström (2001) who have suggested that long and short interest rates should move in the same direction whenever monetary policy responds to economic developments (endogenous policy), but in opposite directions whenever policy responds to changes in policy preferences (exogenous policy).

[9] The series of surprises are on an Executive Board meeting-by-meeting basis and are converted into a time series of surprises with the same frequency as the variables that enter the VAR. If a meeting occurs in some period t, the associated surprise is assigned to that period. If multiple Executive Board meetings occur within a period *t*, then the surprises with respect to these meetings are summed up (as in Romer and Romer 2004)

are included in the VAR log-levels. The precise definitions and transformations are described in detail in the appendix. The Bayesian VARs (sign restrictions) have 12 lags and the frequentist VAR has 6 lags. The Bayesian VAR results are based on 5,000 draws from the Gibbs sampler.

Monetary Policy Surprises and an Informationally-Robust Instrument

In this section I describe my measures of monetary policy surprises and an informationally-robust instrument that I use in the vector autoregressive models.

By looking at how the price of a one-month OIS swap changes around a repo rate decision[10], I can calculate the unexpected part of the repo rate change.[11] The OIS swap contracts has Stibor T/N as the underlying variable and reflects an average of the expected interest rate over the coming month. Hence, with a sufficiently narrow window around the policy decision, and assuming that expected information does not change market prices, all variation in the OIS swap price will reflect unexpected news about the current repo rate decision. I use changes over a 3 hour window starting 15 minutes before the policy announcement to identify the surprise. Figure 1 shows the actual change and unexpected components of the repo rate change at each Riksbank monetary policy decision from 2000 to 2019. The blue bars show the actual change in the repo rate at each meeting while the red bars show the measure of the unexpected change. For most of the decisions, the unexpected part of the change in the repo rate is quite small.[12]

One might suspect that monetary policy announcement dates are correlated with announcements done at other central banks and that information from several central banks might affect markets during a particular month. This would violate the exogeneity condition in equation (6) above. Figure 2 shows a scatter plot of the OIS surprise measure and the corresponding Euro Area OIS surprise obtained from the Euro Area Monetary Policy event study Database which is described in Altavilla et al. (2019). The surprises are aggregated (sometimes summed up) to a monthly frequency. If the announcement on October 8, 2008 is excluded the correlation is insignificant.[13] For more details about the calculations, see the appendix.

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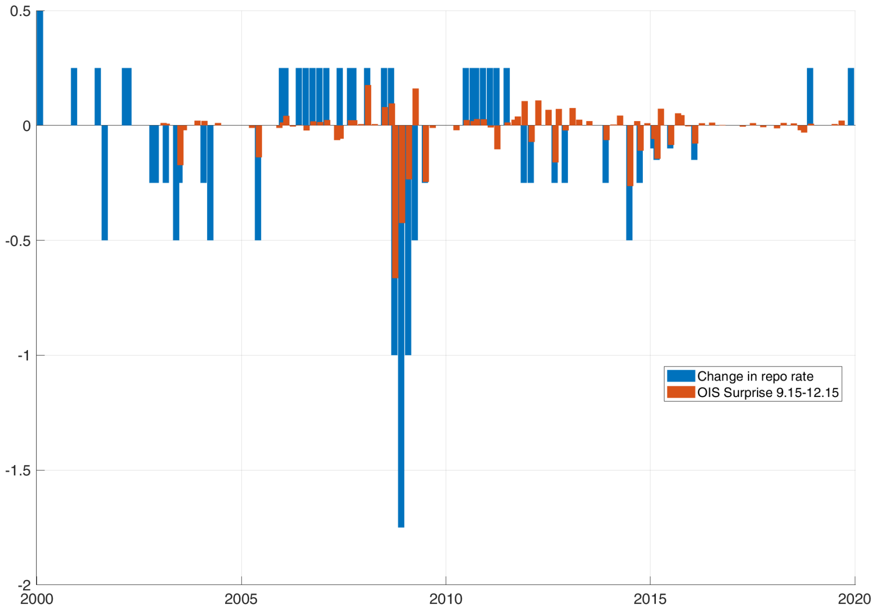
[10] The repo rate is the Riksbank's main policy rate.

[11] The monetary policy surprise measure I use in this paper, has been used previously in the Swedish case by Fransson and Tysklind (2016) and Iversen and Tysklind (2018).

[12] The mean is -0.0015 and is not statistically different from zero (0.002 from 2015-2019). Second, it is not serially correlated; if I regress it on its lagged value, the coefficient is -0.08 with a robust standard error of 0.05 (-0.19 std err 0.08 from 2015-2019).

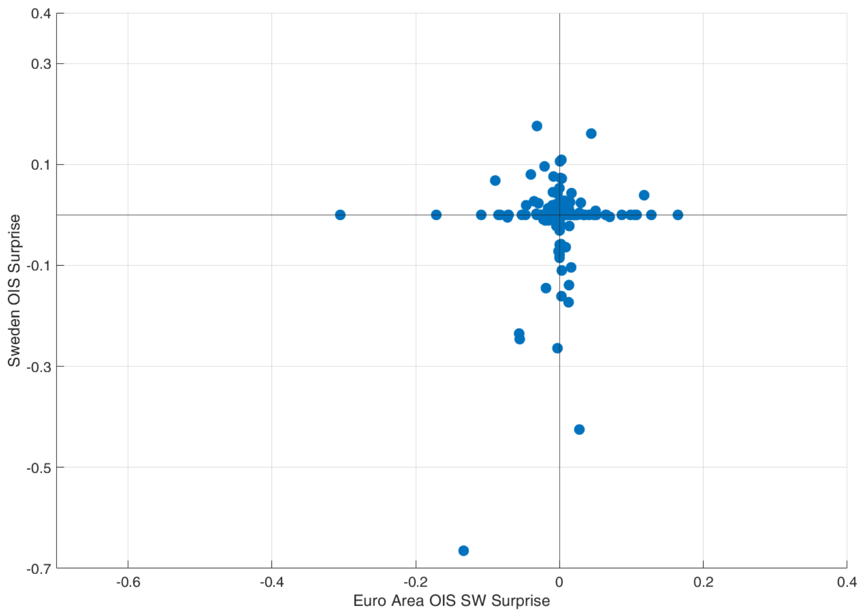
[13] If I regress the monthly OIS surprise measure on the Euro Area OIS SW surprise the coefficient is 0.08 with a HAC standard error of 0.05.

Figure 1. Actual and unexpected changes in the repo rate.



Note: Units are in terms of annual percentage rate.

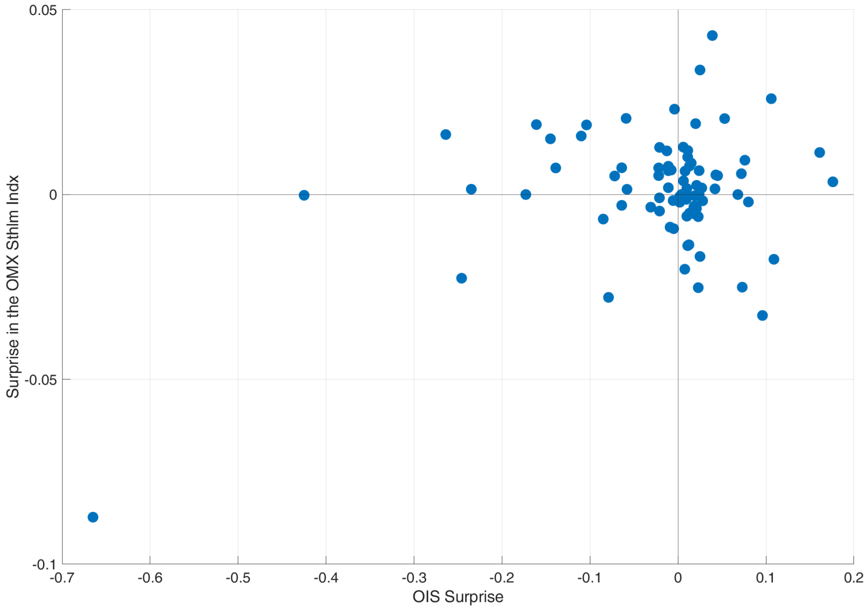
Figure 2. Comparison of monetary policy surprises in Sweden and the Euro Area.



Note. The source for Euro Area surprises is Altavilla et al. (2019). Units are in terms of annual percentage rate.

Figure 3 shows a scatter plot of the monetary policy surprises and the daily change in the in the OMX all-share Stockholm stock market index on the day of the Executive Board monetary policy announcement. This index includes all the shares listed on OMX Nordic Exchange Stockholm. The figure shows that many positive interest rate surprises are accompanied by positive stock market surprises, and many negative interest rate surprises are accompanied by negative stock market surprises. There is also a notable outlier, namely in October 2008. On October 8, 2008 several central banks announced reductions in policy rates in a coordinated action to dampen the consequences of the financial crisis.[14]

Figure 3. Surprises in the overnight index swaps (OIS) denominated in SEK and the OMX All-Share Stockholm stock market index around Riksbank Executive Board announcements.



Note: Each dot represents one Riksbank Executive Board announcement. Units for the OIS surprises are in terms of annual percentage rate and the OMX surprise in terms of log-difference.

The alternative route in accounting for the possible presence of information frictions follows Miranda-Agrippino and Riccio (2020), who in turn build on Romer and Romer (2000), and define monetary policy shocks as shifts to the policy rate that are both unforeseen by market participants, and are not due to the central bank's concerns about either current or anticipated changes in economic conditions. What is novel in this approach is not the method to control for the central bank's private information but the information that is being controlled for. Previous studies have not been able to

[14] On October 8 the Executive Board of the Riksbank decided to cut the repo rate by 0.50 percentage points to 4.25 per cent. This decision was accompanied by reductions in policy interest rates by the Bank of Canada, the Bank of England, the European Central Bank, the Federal Reserve, Sveriges Riksbank and the Swiss National Bank. On the same date the Riksbank granted liquidity assistance to Kaupthing Bank Sverige AB. The OMX index dropped by around 6.6 percent the same day.

also control for a complete set of real time forecasts including policy rate projections from the policy makers that accompany each policy announcement.

To do this I proceed in three steps. First, I project the high-frequency OIS surprises, i.e. the instrument, z_t, on the forecasts, and forecast revisions, published in each Monetary Policy Report since 2007 for the repo rate, real output growth and inflation (KPIF), as in Miranda-Agrippino and Ricco (2020) and Romer and Romer (2004), to control for the central bank's private information. I run the following regression at Riksbank Executive Board meeting frequency:

$$z_m = \alpha_0 + \sum_{j=\{2,8,12\}} \theta_j F_m^{cb} X_{q+j} + \sum_{j=\{2,8,12\}} \vartheta_j F_{\Delta m}^{cb} X_{q+j} + mpi_m. \quad (10)$$

z_m denotes the OIS surprise computed around the Executive board announcement indexed by m. $F_m^{cb} X_{q+j}$ denotes the Riksbank forecasts for the vector of forecasted variables X at horizon $q + j$ and $F_{\Delta m}^{cb} X_{q+j}$ denotes the revision to forecasts between consecutive meetings. The forecast horizon is expressed in quarters for the repo rate and the GDP forecasts and in months for inflation forecasts.[15]

The first step delivers as a residual an instrument for monetary policy shocks (mpi_m) at a meeting frequency that controls for the transfer of information that happens at the time of the policy announcements.

Second, I construct a monthly instrument by assigning the daily mpi_m to each month. Hence, in all cases, I only have one surprise per month. This is due to the fact that the regression are done at a Riksbank Executive Board meeting frequency which only occurs in distinct months. Months without a meetings are assigned a zero.

Finally, I account for the possibility of slow absorption of information by the agents, by removing the autoregressive component in the monthly surprises. Here I let $\overline{mpi}_t$ denote the result of the monthly assignment described in the previous step. The monthly monetary policy instrument mpi_t is finally constructed as the residuals of the following regression:

$$\overline{mpi}_t = \phi_0 + \sum_{j=1}^{6} \phi_j \, \overline{mpi}_{t-j} + mpi_t. \quad (11)$$

I run the regression specified in equation (11) using only observations that correspond to $\overline{mpi}_t$ readings that are non-zero. In months without meetings $\overline{mpi}_t$ is equal to zero.

[15] Note that the goal of this regression is not to estimate the Riksbank's reaction function as well as possible. What I am trying to do is to purge the monetary policy surprises of movements taken in response to useful information about future economic developments.

The Riksbank forecasts for the vector of variables X I use are real time forecast and start in 2007. The reason for starting in 2007 is that forecasts for the repo rate are not available before 2007. The forecasts are published at the exact same moment as the policy decision is announced which is a unique feature of the data I use. Another unique feature of the data is that I can control for the whole forecasting and policy horizon of the Riksbank and that I control for the policy makers' forcasts. The papers who developed and extended this technique, e.g. Romer and Romer (2004) and Miranda-Agrippino and Ricco (2020), are only able to control for a very short forecast horizon of Greenbook forecasts which are staff forecasts. If policymakers e.g. react to an expected increase in inflation further out than two quarters by tightening monetary policy to partially offset it, then a monetary contraction will appear to cause higher inflation if these anticipatory movements are not explicitly allowed for. This should be less of a concern in my context since I am able to control for forecasts for the entire forecast horizon of the central bank of three years.

The estimated equation (i.e. eq. 10), using the sample period January 2007 December 2019, is shown in Table 2. The R^2 of the regression is 0.51. This suggests that a substantial fraction of the OIS surprises over the last thirteen years can be explained by responses to forecasts of future interest rates, real GDP growth and inflation. Thus, it is certainly possible that not controlling for these responsive actions could bias estimates of the effects of policy. Regarding forecasting horizon I note that longer run forecasts for inflation and output appear to be of greatest importance in explaining market surprises.

Table 1. Determinants of the market-based OIS surprises (z_m).

	Quarters/Months ahead	Coefficient	Standard error
Constant		-0.667	0.476
Forecast of the repo rate	2	-0.106**	0.04
	8	0.144**	0.065
	12	-0.053	0.036
Forecast of CPIF inflation	2	-0.009	0.024
	24	0.241***	0.090
	36	0.067	0.319
Forecast GDP growth	2	-0.003	0.005
	8	-0.088***	0.026
	12	0.112**	0.048
Change in forecasted repo rate since previous meeting	2	0.09	0.065
	8	0.056	0.070
	12	-0.106	0.077
Change in forecasted CPIF inflation since previous meeting	2	0.013	0.031
	24	-0.254**	0.125
	36	0.351	0.351
Change in forecasted GDP growth since previous meeting	2	-0.007	0.012
	8	-0.055	0.075
	12	-0.091*	0.051

Note: The dependent variable is the market-based OIS surprises (z_m). The independent variables are the Riksbank Executive Board forecasts and change in the forecasts from the previous meeting. $R^2 = 0.51; D.W. = 2.4; s.e.e. = 0.076; N = 74$. The sample is all regularly scheduled Executive Board meetings over the period 2007:1-2019:12. Standard errors are computed by Newey–West HAC. * 10% level of significance. ** 5% level of significance. *** 1% level of significance.

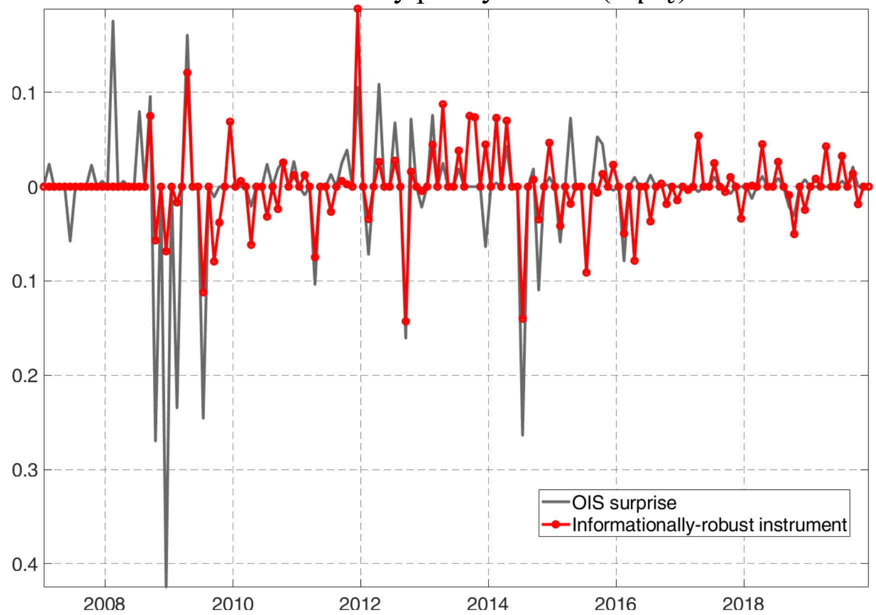
In Figure 4 I plot the OIS surprise at monthly frequency (z_t) and the instrument constructed with this approach (mpi_t). Like Miranda-Agrippino and Ricco (2020), for the U.S. case, I note that discrepancies between the two series are particularly evident during times of economic distress in 2008-2009 and in 2012.

3.1. Impulse Responses - The Transmission of Monetary Policy

Figure 5 and 6 shows impulse responses to a contractionary monetary policy shock using the frequentist exogenous variable approach and the Bayesian combined sign-restrictions and external instrument approach respectively using the market based instrument (z_t).[16]

[16] I follow Paul (2020) and project the series of surprises on the lags of $Y_{N_m+1:n,t}$ and the residual from this projection is used as the exogenous variable z_t, which ensures that z_t is uncorrelated with the remaining regressors in (2). Like Paul I find that the impulse responses are nearly equivalent when I use the original z_t instead. Based on Lunsford and Jentsch (2016), confidence bands are computed via a residual-based moving block bootstrap, resulting in relatively wide confidence intervals. Lunsford and Jentsch (2016) show that a residual-based moving block bootstrap is asymptotically valid for inference on statistics that are smooth functions of the VAR coefficients, the variance matrix of the VAR innovations, and the covariance matrix of the VAR innovations with the proxy variables. In contrast, wild bootstraps are not asymptotically valid for these statistics.

Figure 4. Surprises in the overnight index swaps (OIS) denominated in SEK (z_t) and the informationally-robust instrument for monetary policy shocks (mpi_t).



Note: Units are in terms of annual percentage rate.

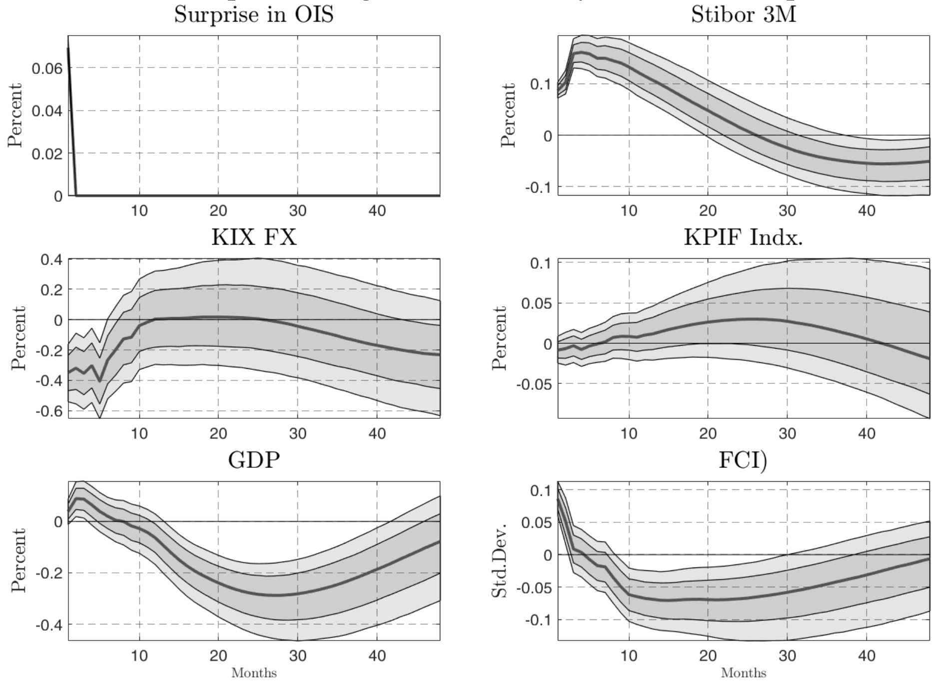
The figures show standard impulse responses of macroeconomic variables and the exchange rate (the figures show impulse-responses in levels).[17] The short term nominal interest rate increases persistently. The GDP response is both significant and persistent and turns negative after approximately a year. The response of the price level is insignificant and the response of the exchange rate is very immediate and short lived. The financial conditions index (FCI) response shows initially that financial conditions are looser (the index is constructed such that positive values are associated with expansionary financial conditions). However, the responses turn contractionary after 10-12 months. The responses show a tendency to be of the opposite direction from what one would expect from the conventional interpretation of monetary shocks. Hence, the information effect might possibly be at play.

In terms of magnitudes, a one standard deviation monetary policy shock results in an 11 bps increase in the nominal 3-month Stockholm interbank rate, a 0.35 percent immediate appreciation of the nominal trade-weighted exchange rate, a 0.35 percent decrease in GDP. The CPIF-XE price level excluding energy decreases by about of 0.05 percent.[18]

[17] The variables in the VAR enter in log-levels. Including the variables in first-differences in the VAR yields very similar results.

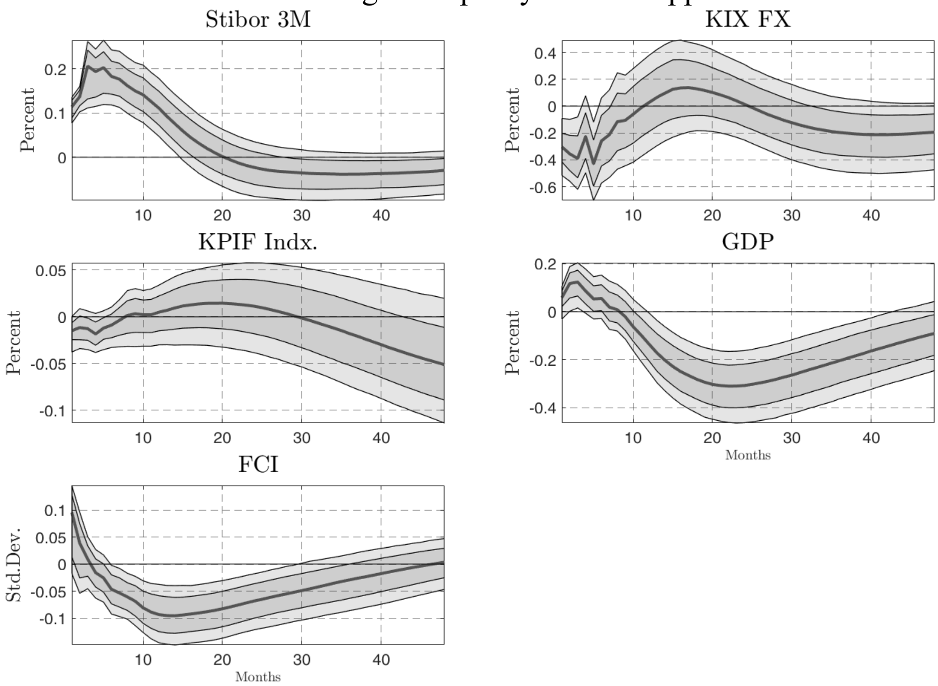
[18] To be confident that a weak instrument problem is not present, Stock et al. (2002) recommend a threshold value of ten for the F-statistic from the first-stage regression in the external instrument approach. The F-statistic in my case is 65.4 which is safely above this threshold.

Figure 5. Impulse responses to a one standard deviation contractionary monetary policy shock, baseline Bayesian VAR with a positive sign restriction only on the OIS surprise.



Note: Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). The estimation sample is February 2000 to December 2019. Units are in percent deviation, except the OIS surprise and the interest rate which are in terms of annual percentage rate (APR) and the FCI which is in terms of standard deviations.

Figure 6. Impulse responses to a one standard deviation contractionary monetary policy shock, baseline frequentist VAR with Paul's exogenous proxy variable approach.



Note. Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). Residual-based moving block bootstrap as in Lunsford and Jentsch (2016) is used to obtain confidence bands. The estimation sample is February 2000 to December 2019. Units are in percent deviation, except the interest rate which is in terms of annual percentage rate (APR) and the FCI which is in terms of standard deviations.

3.1.1. Do Swedish Monetary Policy Surprises contain Central Bank Information?

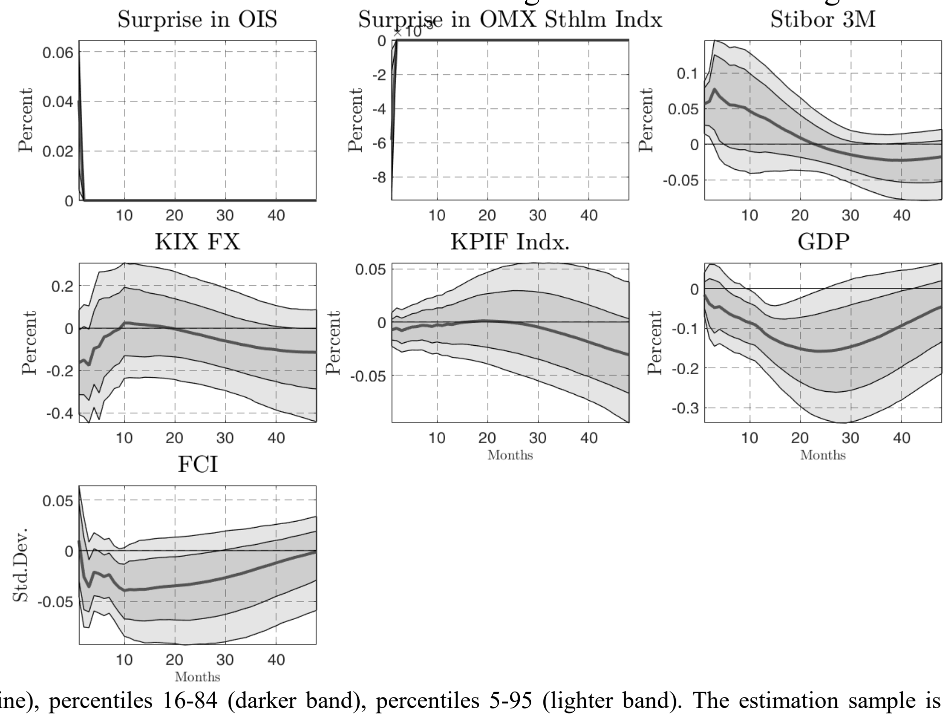
Figure 3 indicates that a number of Executive Board announcements are associated with stock market responses that move in the "wrong" direction suggesting that information effects may be of importance. Moreover, the informationally-robust instrument (mpi_t) differs also to some extent from the market based instrument (z_t) which also suggests that information effects may be of importance. I begin this section by discussing the sign-restriction approach and end with an analysis of the informationally-robust instrument.

Figures 7 and 8 present the impulse responses when monetary policy shocks and central bank information shocks are separately identified using the sign restrictions in table 1. A monetary policy shock is associated with a 2 to 4 basis points increase of the OIS swap rate and a 2 to 8 basis points drop in the OMX index on impact. The subsequent responses on macroeconomic variables are not overall that different from the impulse responses in figures 5 and 6 but some observations are more obvious. First, the FCI and GDP responses are positive for about a year for information surprises but significantly negative for monetary policy shocks. Real GDP and the price level both decline persistently by about 0.15 percent and 0.05 percent respectively. The magnitudes are comparable with Jarociński and Karadi who reported 10 and 5 basis points for real GDP and the price level for both the United States and for the Euro Area. The CPIF-XE price level response is somewhat more negative for the monetary policy shock compared with the information shock but the difference is certainly not dramatic. Similar to Jarociński and Karadi I find that information shocks generate more persistent responses for interest rates. Overall, the results indicate that information surprises imply qualitatively similar effects as in Jarociński and Karadi (2020). The magnitude of the responses is smaller in the Swedish case however. Hence, the stock market response around the policy announcement are not as informative about the information effect of the announcement on the economy as in the US case.

The stock market response in October 2008 (the unannounced and coordinated policy response) is more than twice as big as the second largest response so in order to investigate if this observation affects the results I redo the above exercises with the only difference of setting the surprises in October 2008 to zero. Figures 9 to 11 present the results. It is clear from the figures that the above results are quite notably affected by the events in October 2008. The responses following the information shock is now even weaker and the responses for a monetary policy shock with and without the sign restrictions are more similar. Hence, the removal of this outlier indicates that the presence of central bank information shocks do not bias the standard high-frequency identification of monetary policy shocks as much as in the US case, at least as estimated with the Jarociński and Karadi (2020) sign-restriction approach taking un-announced meetings into account.

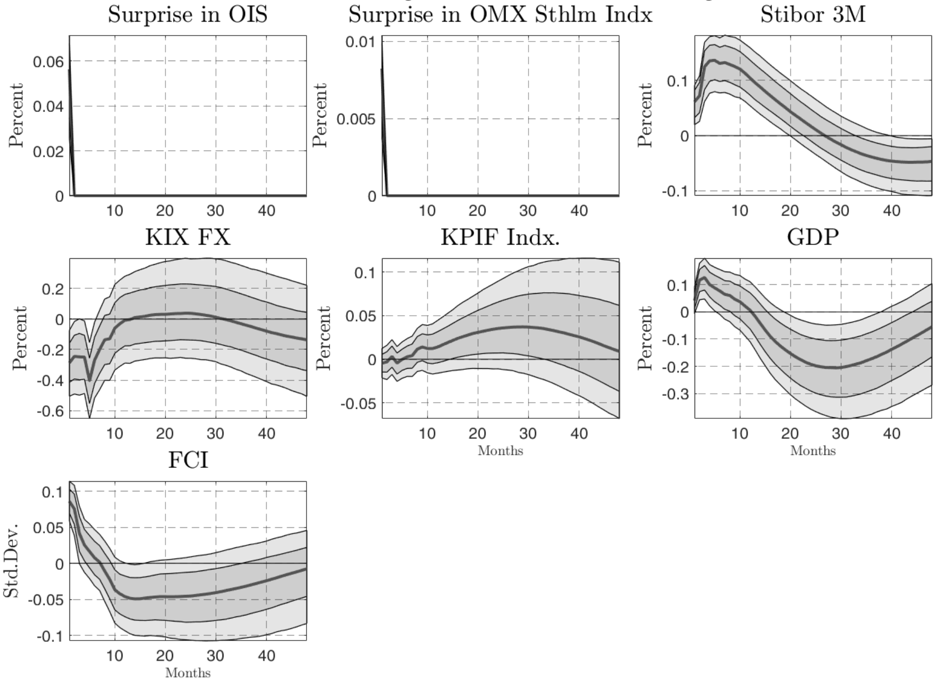
Jarociński and Karadi (2020) suggest that a simpler exercise can lead to similar impulse responses as those obtained with their sign restrictions. The assumption is that each month can be classified either as hit by a pure monetary policy shock or by a pure central bank information shock. This contrasts with the sign restrictions approach which allows for a combination of the two shocks in each month. In particular, I use the OIS surprises in the months when the stock price surprise had the opposite sign of the OIS surprise as the proxy for monetary policy shocks (the proxy is zero otherwise). A monetary policy shock then corresponds to the OIS surprises found in the upper left and lower right quadrants in Figure 3. I use the OIS surprises in the remaining months as the proxy for central bank information shocks (again, the proxy is zero otherwise). I use this approach in the frequentist VAR and the results are presented in figures 12 and 13.

Figure 7. Impulse responses to a one standard deviation contractionary monetary policy shock, baseline Bayesian VAR with Jarociński and Karadi sign restrictions according to Table 1.



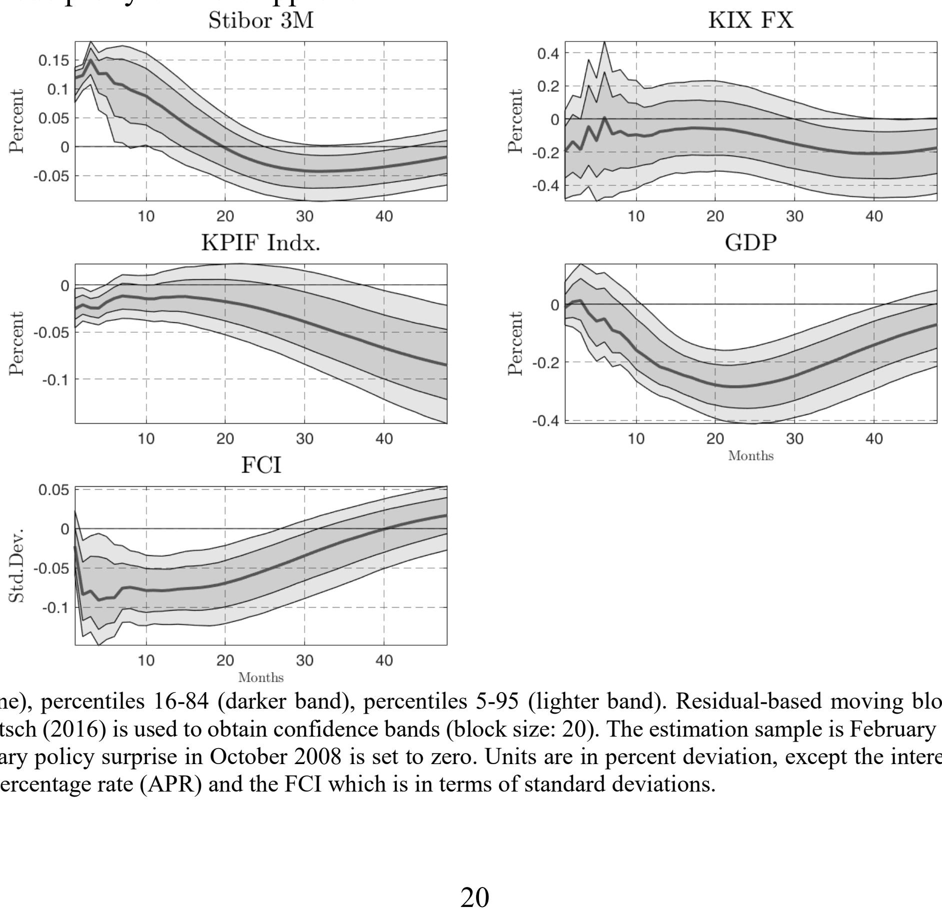
Note: Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). The estimation sample is February 2000 to December 2019. Units are in percent deviation, except the OIS surprises and the interest rate which are in terms of annual percentage rate (APR). The OMX index surprise is in terms of log-difference. The FCI is in terms of standard deviations.

Figure 8. Impulse responses to a one standard deviation central bank information shock, baseline Bayesian VAR with Jarociński and Karadi sign restrictions according to Table 1.



Note: Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). The estimation sample is February 2000 to December 2019. Units are in percent deviation, except the OIS surprises and the interest rate which are in terms of annual percentage rate (APR). The OMX index surprise is in terms of log-difference. The FCI is in terms of standard deviations.

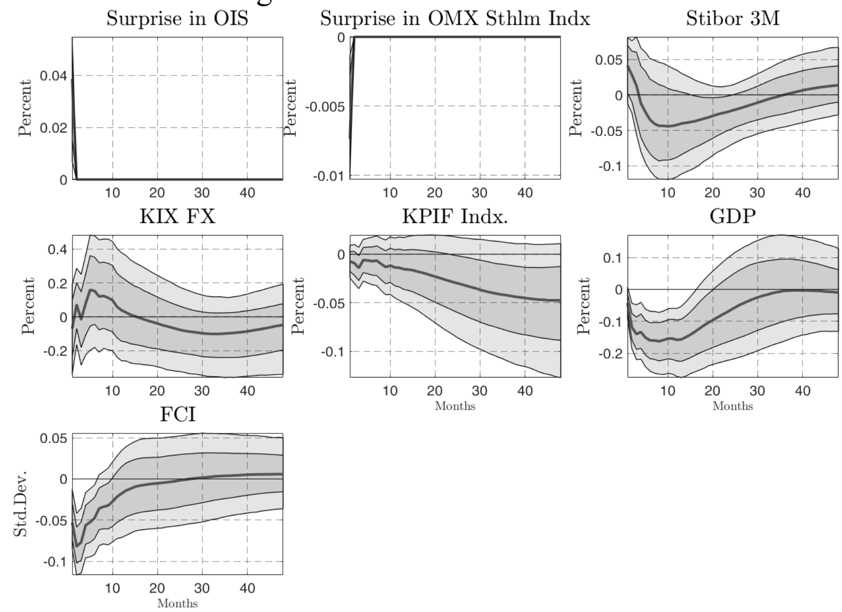
Figure 9. Impulse responses to a one standard deviation contractionary standard monetary policy shock excluding the monetary policy surprise in October 2008, baseline frequentist VAR with Paul's exogenous proxy variable approach.



Note. Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). Residual-based moving block bootstrap as in Lunsford and Jentsch (2016) is used to obtain confidence bands (block size: 20). The estimation sample is February 2000 to December 2019. The monetary policy surprise in October 2008 is set to zero. Units are in percent deviation, except the interest rate which is in terms of annual percentage rate (APR) and the FCI which is in terms of standard deviations.

The results confirm the findings from the more sophisticated sign-restrictions approach above namely that central bank information shocks do not bias the standard high-frequency identification of monetary policy shocks as much as in the U.S. or Euro Area cases. There are small differences between monetary policy and information shocks which is contrary to what is found by Jarociński and Karadi (2020) for the U.S. and the Euro area. One exception is the nominal exchange rate which appreciates significantly during the first 8 months for monetary policy shocks but is insignificant for information shocks.

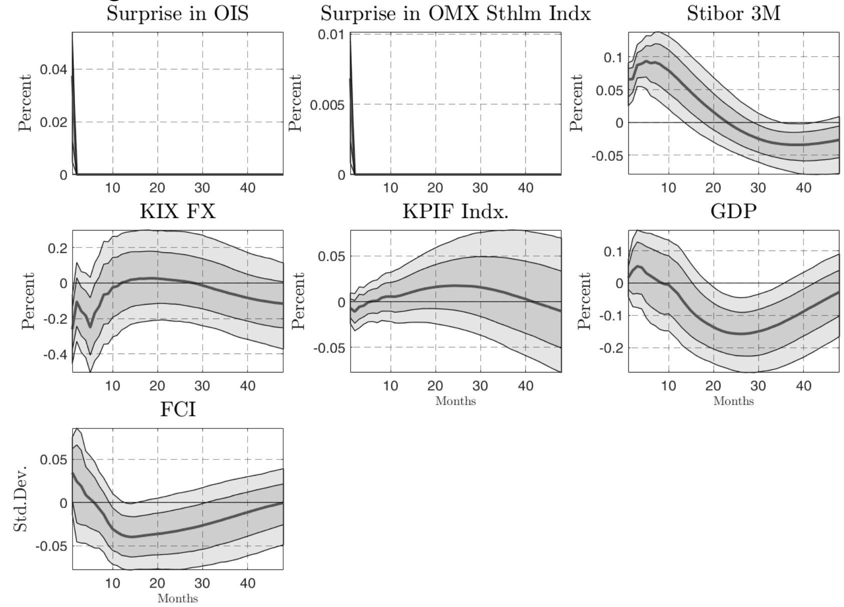
Figure 10. Impulse responses to a one standard deviation contractionary monetary policy shock excluding the monetary policy surprise in October 2008, baseline Bayesian VAR with Jarociński and Karadi sign restrictions according to Table 1.



Note: Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band).The estimation sample is February 2000 to December 2019. The monetary policy surprise in October 2008 is set to zero. Units are in percent deviation, except the OIS surprises and the interest rate which are in terms of annual percentage rate (APR). The OMX index surprise is in terms of log-difference. The FCI is in terms of standard deviations.

The lack of clear evidence of an information advantage for the central bank which was reported above could be related to, or is at least not inconsistent with, the communication strategies implemented by Sveriges Riksbank. The Riksbank is one of the most transparent central banks in the world and the public has had access to a full set of forecasts, including the policy interest rate, for almost twenty years. Hence, the information set of the Riksbank should be well known to the public. The informationally-robust instrument will provide further insights into this question.

Figure 11. Impulse responses to a one standard deviation central bank information shock excluding the monetary policy surprise in October 2008, baseline Bayesian VAR with Jarociński and Karadi sign restrictions according to Table 1.



Note: Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). The estimation sample is February 2000 to December 2019. Units are in percent deviation, except the OIS surprises and the interest rate which are in terms of annual percentage rate (APR). The OMX index surprise is in terms of log-difference. The FCI is in terms of standard deviations.

Figure 13 and 14 reports impulse response functions to a monetary policy shock identified using the informationally robust instrument mpi_t, and the central bank information shock cbi_t[19] estimated in a VAR with Paul's exogenous proxy variable approach. The F-statistic from a first-stage regression is 19.7 which is above the Stock et al. (2002) recommend a threshold value reported above. The value is notably lower than for the OIS surprise instrument but these tests remain silent on the exogeneity of the instruments. Contamination by other macroeconomic shocks could in inflate the first-stage F-statistics. Interestingly, results in figure 13 and 14 provide further empirical support to the results found above but here with a very different method to separate monetary policy shocks from central bank information shocks. Responses to monetary policy shocks and central bank information shocks are overall very much in line with the results reported above. The differences pertain mostly to the response of CPIF inflation which is stronger for the information shock.

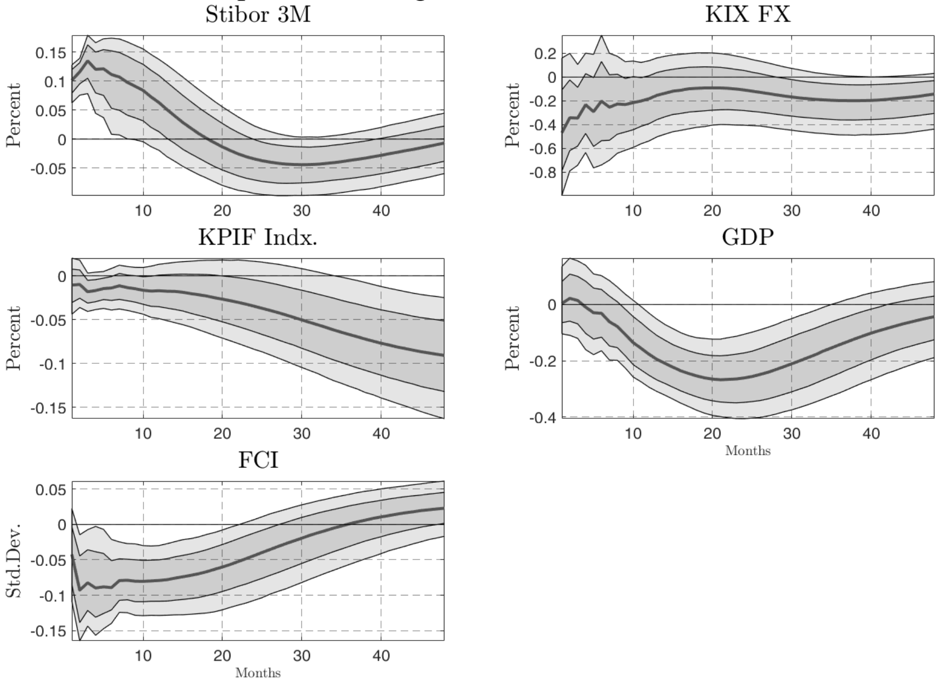
Hence, the results do not seem to be affected by the method by which monetary policy shocks are identified and separated from central bank information shocks. The shocks do not give rise to widely

[19] The `informational' component of the monetary policy surprises (cbi_t), is captured by the fitted component of Eq. (10), aggregated at monthly frequency.

different responses as was reported by Miranda-Agrippino and Riccio (2020) and Jarociński and Karadi (2020). While both shocks raise the nominal interest rate by the same amount on impact, the information shock is not followed by an economic expansion at business cycle frequency which would be consistent with the view that a rate increase can signal to market participant that the central bank is expecting a stronger economy. Hence, these results do not support the view that market participants extract from central bank announcements information on the state of the economy to which the central bank is likely to respond.

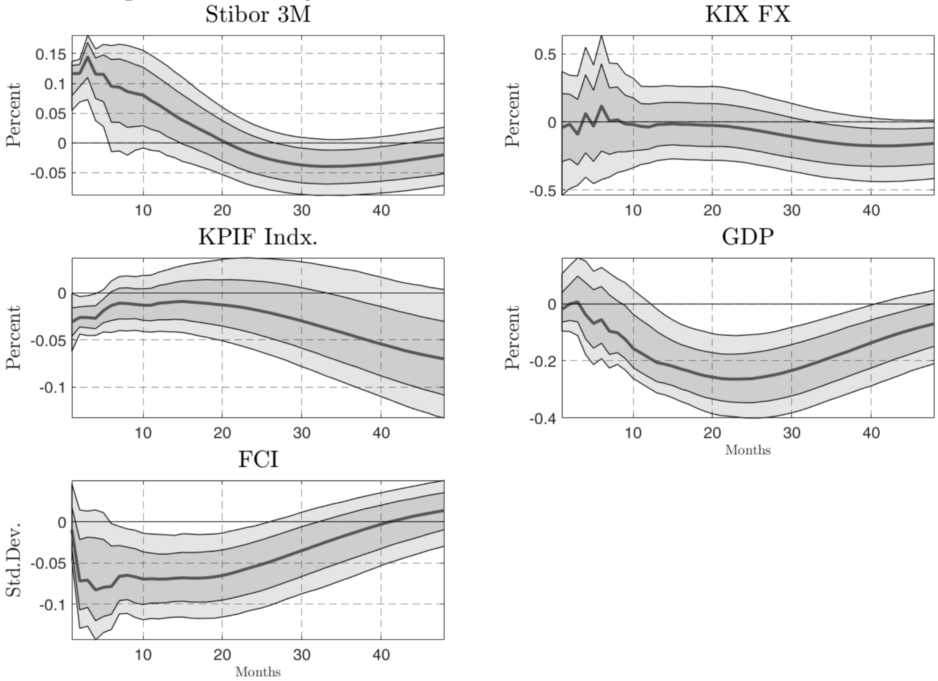
The bottom line is that the most important aspect is to account for un-announced extra meetings which are not accompanied by a full set of central bank forecasts and explanations in the form of a monetary policy report.

Figure 12. Impulse responses to a one standard deviation contractionary monetary policy shock, baseline frequentist VAR with `poor man's' sign restrictions.



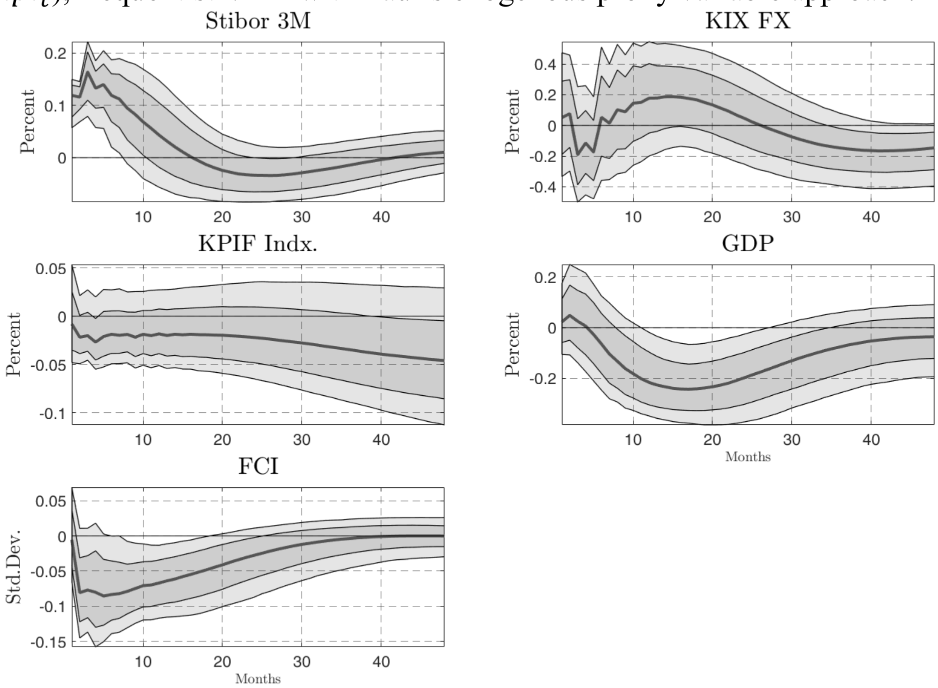
Note. Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). Residual-based moving block bootstrap as in Lunsford and Jentsch (2016) is used to obtain confidence bands (block size: 20). The estimation sample is February 2000 to December 2019. The surprises in October 2008 are set to zero. Units are in percent deviation, except the interest rate which is in terms of annual percentage rate (APR) and the FCI which is in terms of standard deviations.

Figure 13. Impulse responses to a one standard deviation central bank information shock, baseline frequentist VAR with `poor man's' sign restrictions.



Note. Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). Residual-based moving block bootstrap as in Lunsford and Jentsch (2016) is used to obtain confidence bands (block size: 20). The estimation sample is February 2000 to December 2019. The surprises in October 2008 are set to zero. Units are in percent deviation, except the interest rate which is in terms of annual percentage rate (APR) and the FCI which is in terms of standard deviations.

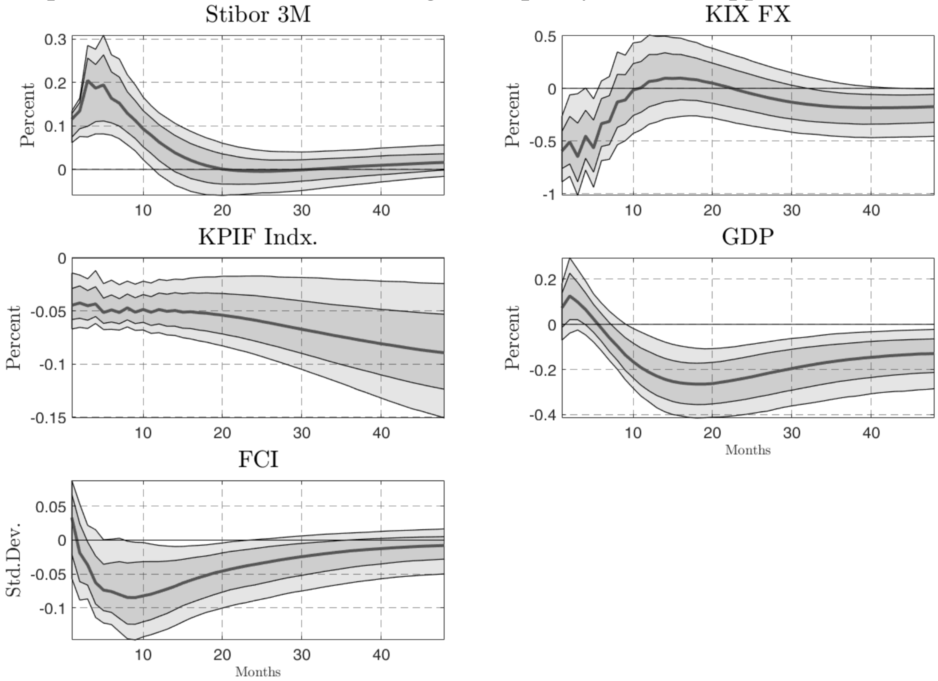
Figure 14. Impulse responses to a one standard deviation contractionary informationally robust instrument (mpi_t), frequentist VAR with Paul's exogenous proxy variable approach.



Note. Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). Residual-based moving block bootstrap as in Lunsford and Jentsch (2016) is used to obtain confidence bands (block size: 20). The estimation sample is February 2007 to December

2019. Units are in percent deviation, except the interest rate which is in terms of annual percentage rate (APR) and the FCI which is in terms of standard deviations.

Figure 15. Impulse responses to a one standard deviation contractionary central bank information shock (cbi_t), frequentist VAR with Paul's exogenous proxy variable approach.

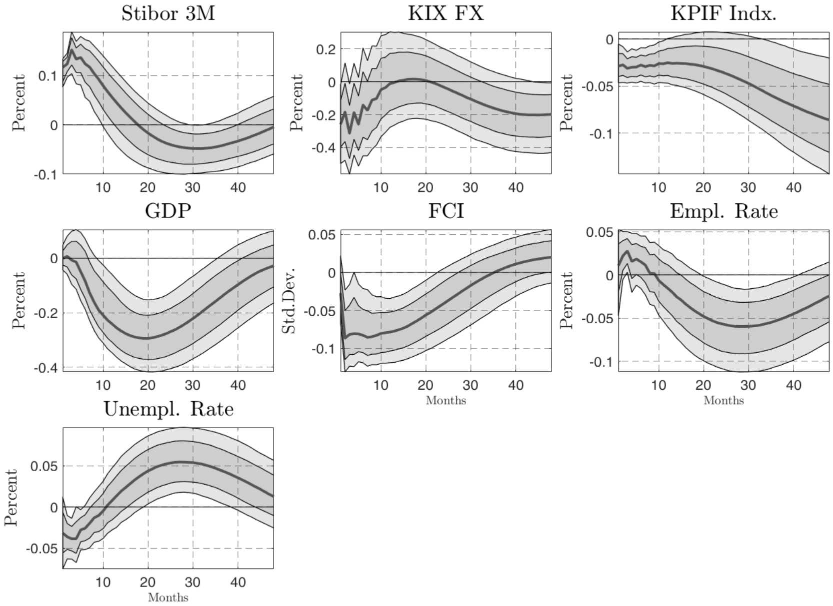


Note. Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). Residual-based moving block bootstrap as in Lunsford and Jentsch (2016) is used to obtain confidence bands (block size: 20). The estimation sample is February 2007 to December 2019. Units are in percent deviation, except the interest rate which is in terms of annual percentage rate (APR) and the FCI which is in terms of standard deviations.

3.2. Impulse Responses - Additional results

In this section, I consider alternative VAR specifications that help me to characterize the transmission of monetary policy in Sweden. Specifically, I augment the frequentist VAR with monthly data on employment and unemployment; inflation expectations, money supply; housing prices; a monthly series of total (real) credit extended by monetary and financial institutions to households; a stock market index for banks; household deposit rates, mortgage lending rates and a mortgage interest rate spread. I use the OIS instrument (z_t) adjusted for un-announced meetings in this section. The reason for not using the informationally-robust instrument is because it is only available from 2008 onwards. This choice hinges naturally also on the results in the previous section that there is a small difference between monetary policy shocks and central bank information shocks.

Figure 16. Impulse responses of labor market variables to a one standard deviation contractionary monetary policy shock.



Note. Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). The monetary policy instrument are set to zero in October 2008. Frequentist VAR with Paul's exogenous proxy variable approach. Residual-based moving block bootstrap as in Lunsford and Jentsch (2016) is used to obtain confidence bands (block size: 20). The estimation sample is February 2001 to December 2019. Units are in percent deviation, except the interest rate which is in terms of annual percentage rate (APR) and the FCI which is in terms of standard deviations.

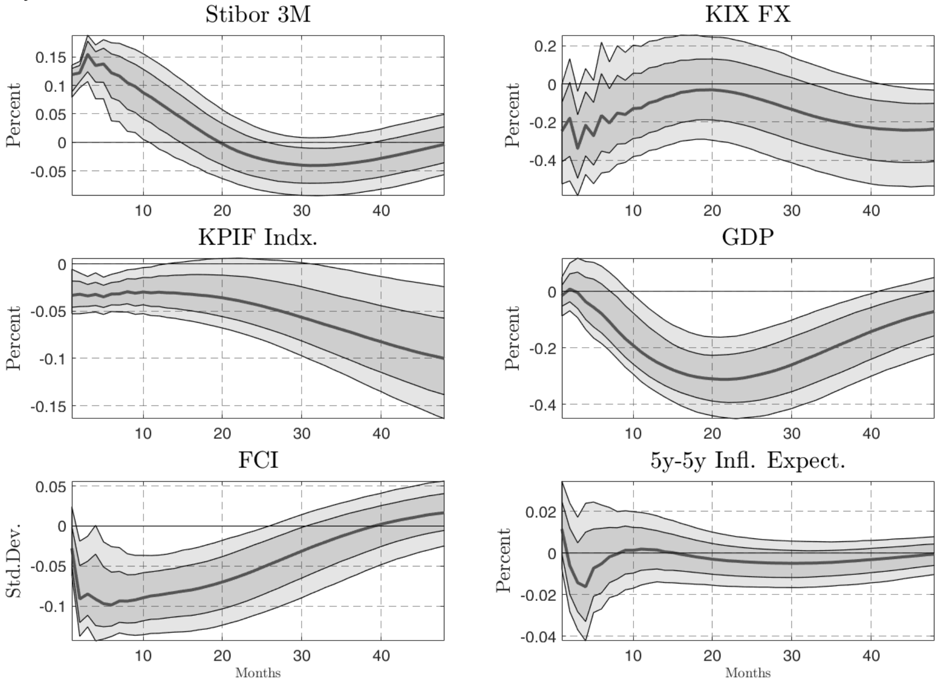
Unemployment and Employment. I first consider the specification augmented with the employment rate and unemployment rate. The impulse responses of these labor market variables (reported in figure 16, bottom panels) show that the decrease in real GDP documented in the previous section is also coupled with a rise in the unemployment rate and a fall in the employment rate.[20] In particular, the unemployment rate barely moves on impact and then slowly increases, with a statistically significant peak response of 0.05 percentage points after about 2 years. These magnitudes and dynamics are almost identical to what Cesa-Bianchi et al. (2020) find when applying external instruments in a VAR for the U.K.

Inflation expectations. Next, I consider the baseline specification augmented with the 5-year, 5-year forward inflation expectation rate (figure 17). This series is a measure of expected inflation (on average) over the five-year period that begins five years from today. Inflation expectations in Sweden at this horizon appear well anchored as the expectations barely move and the responses are

[20] The delayed depreciation of the KIX weighted Krona exchange rate (the positive response of KIX FX in Figure 13) is (in this specification with labor market variables) somewhat sensitive to including the monetary policy surprise in December 2008. If December 2008 is excluded the KIX FX impulse response is insignificant but the dynamics of the labor market variables remains the same. In December 2008 the Riksbank undertook a series of both SEK and USD loans and the monetary policy meeting was unexpectedly brought forward from the 16 December to 3 December.

insignificant. This is an indication that the transmission of monetary policy shocks in Sweden involves changes in real interest rates rather than changes in inflation expectations.

Figure 17. Impulse responses of inflation expectations to a one standard deviation contractionary monetary policy shock.



Note. Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). The monetary policy instrument are set to zero in October 2008. Frequentist VAR with Paul's exogenous proxy variable approach. Residual-based moving block bootstrap as in Lunsford and Jentsch (2016) is used to obtain confidence bands (block size: 20). The estimation sample is February 2001 to December 2019. Units are in percent deviation, except the interest rate which is in terms of annual percentage rate (APR) and the FCI which is in terms of standard deviations.

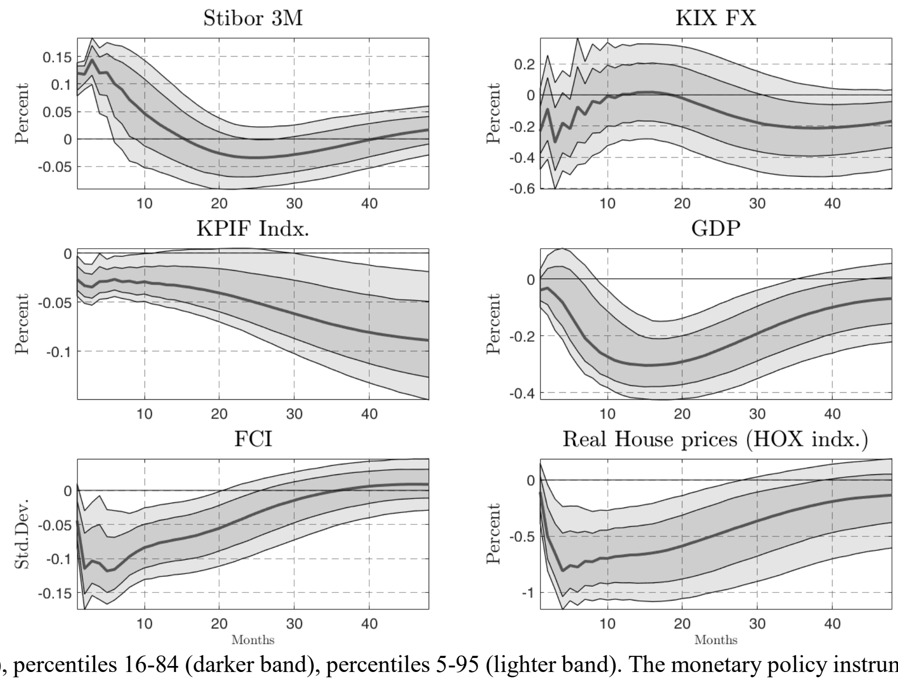
Housing prices, credit and money supply.[21] I add to the baseline VAR a measure of real house prices as well as three measures of credit, namely lending extended by financial institutions to households, M1 and M3. Figures 18-20 report the impulse response of real house prices, mortgage lending and M1 and M3 respectively. Real house prices fall by around 0.75 percent. The impact is fairly instant and persistent with large uncertainty bands. These results are in line with Bjørnland and Jacobsen (2013) who also find a strong and prolonged effect on house prices, emphasizing the role of house prices in the monetary policy transmission mechanism. Real mortgage lending to households (figure 19) show a more delayed response to a contractionary monetary policy shock compared with real house prices and has a similar magnitude and dynamics as real GDP (leaving debt-to-gdp almost unaffected).[22]

[21] The impact of monetary policy shocks on house prices has been studied in a number of papers such as Iacoviello (2005), Iacoviello and Minetti (2008), Goodhart and Hoffmann (2008), Musso et al. (2011), and Pescatori and Laseen (2020).
[22] The response to the MFI lending to GDP ratio (debt-to-gdp ratio) is not statistically significant (not shown).

This is consistent with a slow turnover of the housing stock which is discussed in Laseen and Strid (2013).

The liquidity effect – the interest rate increase is accompanied by a drop in M1 - is an important feature in many theories of the monetary transmission mechanism. When including monetary aggregates in the VAR model, the responses to a monetary policy surprise, displayed in figure 20, show a clear liquidity effect: the interest rate increase is accompanied by a sharp drop in M1. This is consistent with the often held view of central bankers who usually think of themselves as controlling monetary aggregates by means of interest rates, with higher interest rates accompanied by a contraction of M1 (see e.g. Leeper, Sims and Zha 1996 for a discussion). I find a more gradual decrease in M3. Hence, an interest rate tightening gives rise to a temporary substitution effect from money components that bear no or regulated interest to time deposits and money market funds that are included in the broader money aggregates.[23]

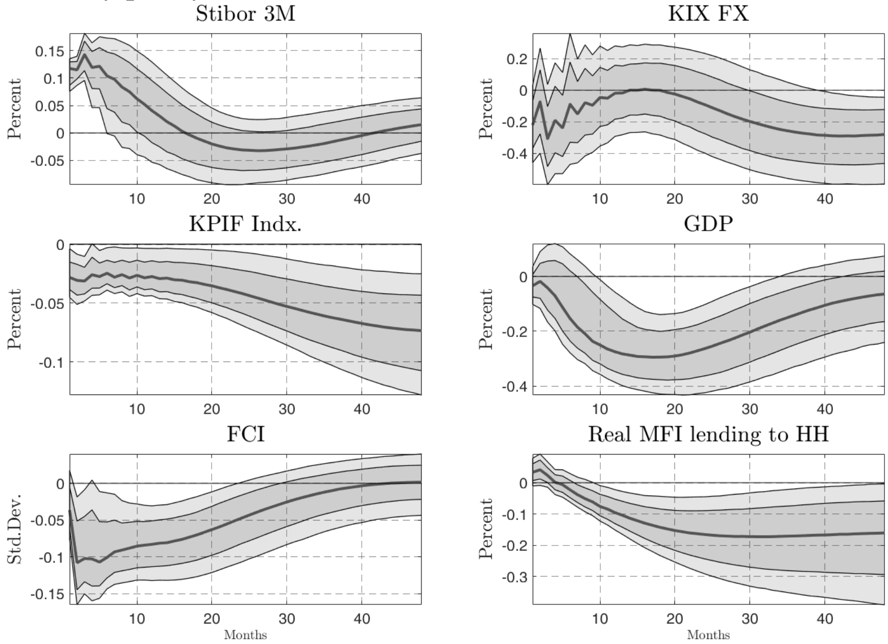
Figure 18. Impulse responses of housing prices to a one standard deviation contractionary monetary policy shock.



Note. Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). The monetary policy instrument are set to zero in October 2008. Frequentist VAR with Paul's exogenous proxy variable approach. Residual-based moving block bootstrap as in Lunsford and Jentsch (2016) is used to obtain confidence bands. The estimation sample is February 2005 to December 2019. Real HOX index is deflated with the CPIF excluding energy index. The HOX Index (Nasdaq OMX Valueguard-KTH Housing) is a quality-adjusted price index for condominiums and houses in Sweden. Units are in percent deviation, except the interest rate which is in terms of annual percentage rate (APR) and the FCI which is in terms of standard deviations.

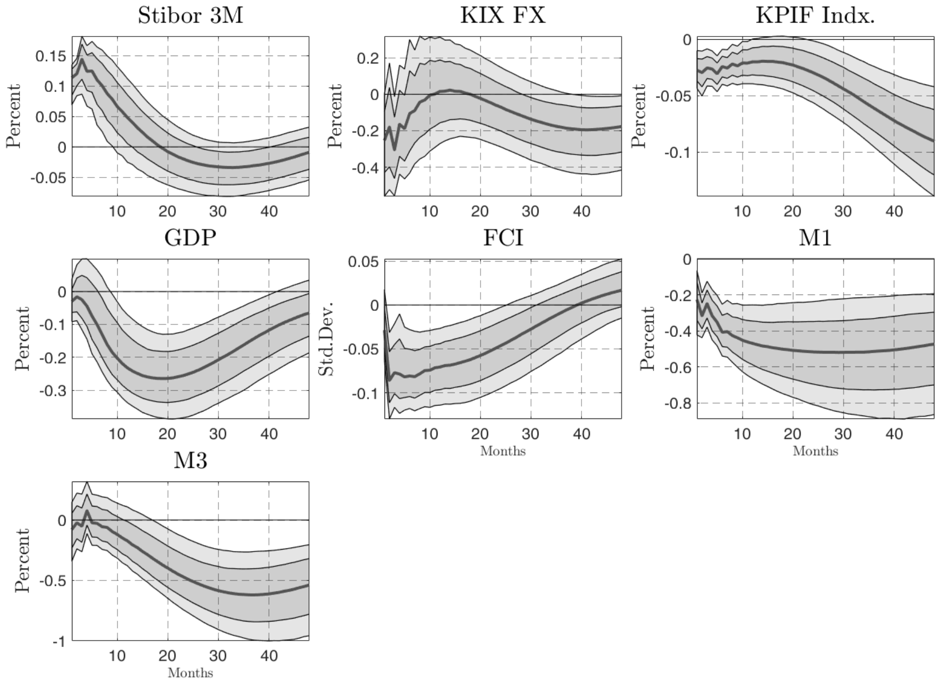
[23] The difference between M3 and M1 increases significantly for 8-10 month after a monetary policy shock (not shown).

Figure 19. Impulse responses of real MFI lending to households to a one standard deviation contractionary monetary policy shock.



Note. Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). The monetary policy instrument are set to zero in October 2008. Frequentist VAR with Paul’s exogenous proxy variable approach. Residual-based moving block bootstrap as in Lunsford and Jentsch (2016) is used to obtain confidence bands. The estimation sample is December 2005 to December 2019. MFI:s' lending to households is from Table 7.4.1 in Financial Market Statistics and is deflated with the CPIF excluding energy index. Units are in percent deviation, except the interest rate which is in terms of annual percentage rate (APR) and the FCI which is in terms of standard deviations.

Figure 20. Impulse responses of money supply to a one standard deviation contractionary monetary policy shock.



Note. Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). The monetary policy instrument are set to zero in October 2008. Frequentist VAR with Paul’s exogenous proxy variable approach. Residual-based moving block bootstrap as in Lunsford and Jentsch (2016) is used to obtain confidence bands. The estimation sample is February 2000 to December 2019. Units are in percent deviation, except the interest rate which is in terms of annual percentage rate (APR) and the FCI which is in terms of standard deviations.

Bank's stock market index. In this section I follow English et al. (2018), among others, by measuring the effect of an exogenous change in interest rates on bank equity valuations.[24] I use the OMX Stockholm Banks stock price index as a composite measure of Swedish bank stock prices. The Swedish banking sector consists of relatively few, but large, banks and they are all part of the index. The impulse responses are presented in figure 21. In response to a rise in the general level of interest rates the responses of bank stock prices are consistent with an increase in net interest margins and net income, but then a decline. The overall effect becomes negative after one year. Hence, the near-term improvement in bank stock prices is consistent with the "Samuelson effect" which arises because banks fund a portion of their interest-earning assets with noninterest bearing liabilities, such as demand and transaction deposits, while many other types of retail deposits pay below-market rates that are also somewhat sticky. Thus, when market interest rates increase, rates on core deposits do not rise by as much, and this tends to improve banks' net interest margins, at least in the short run. My results are in line with the findings in English et al. (2018) who find very similar dynamics for U.S. banks' net interest rate margins. Below, I explore this hypothesis and offer a partial explanation for the medium-term decline of net interest income and net income.

Household deposit, mortgage lending rates and mortgage spreads. Finally, I add household deposit and lending rates and a measure of the mortgage spread[25] to the baseline VAR.[26] The impulse responses in figures 22-24 show that deposit rates, lending rates and mortgage spreads increase on impact by about 5, 10 and 10 basis points respectively. The responses are increasing for a few months after the shock, with a peak after about half a year. These impulse responses provide support to the view monetary policy reduces the net worth and liquidity of borrowers which increases the effective cost of credit by more than the change in risk-free rates, thus intensifying the effect of the policy action.

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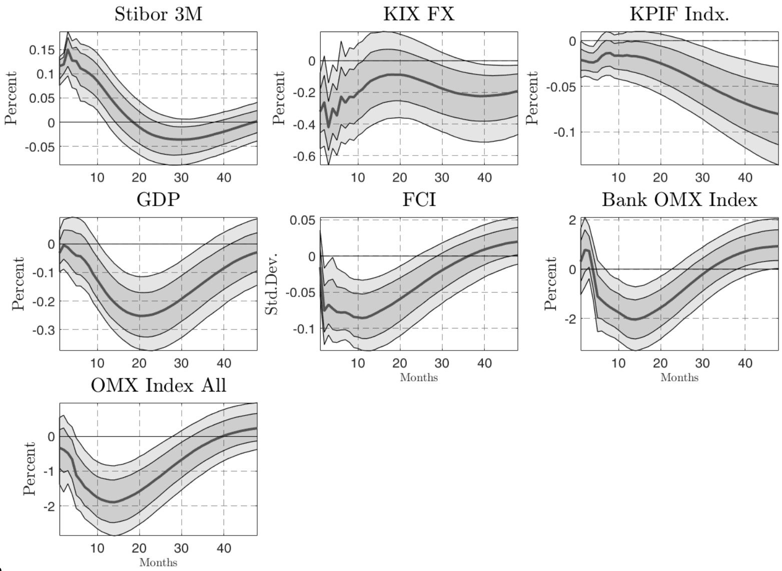
[24] As a theoretical matter, changes in interest rates can have a multitude of effects on the financial strength of banks. These effects may not all work in the same direction. According to conventional wisdom, banks benefit from a steep yield curve because they engage in maturity transformation by borrowing "short" and lending "long". However, a steepening of the yield curve caused by rising long-term interest rates will also result in immediate capital losses on longer-term assets, which may offset part of any benefits of higher net interest margins over time. Moreover, exposure to interest rate risk arises from the banks' ability to fund a portion of their assets with low or zero interest-rate liabilities, such as core deposits. This traditional role of banks implies that an upward shift of the yield curve could result in higher net interest margins over time (Samuelson, 1945). Banks may however hedge interest rate risk through the use of interest rate derivatives or limit its effects on interest income by making longer-term loans at floating rates.

[25] The mortgage spread is measured as the difference between MFI, mortgage credit companies and AIFs' lending rates for housing loans, new agreements (percent) from table 8.1.1 in Statistics Sweden Financial Market Statistics and a Swedish 1 year benchmark government bond yield.

[26] Walentin (2014) finds that mortgage spread shocks impact the real economy by both economically and statistically significant magnitudes and theoretically, the mortgage rate, and thus the mortgage spread, potentially affects aggregate economic variables through several channels: (i) house prices and residential investment through the user cost of housing, (ii) as one relevant rate in the consumption / savings decision and, (iii) the post-interest disposable income of any household with a mortgage.

These magnitudes and dynamics are interestingly almost identical to what Cesa-Bianchi et al. (2020) find for the U.K. and Gertler and Karadi (2015) for the U.S.

Figure 21. Impulse responses of stock prices to a one standard deviation contractionary monetary policy shock.



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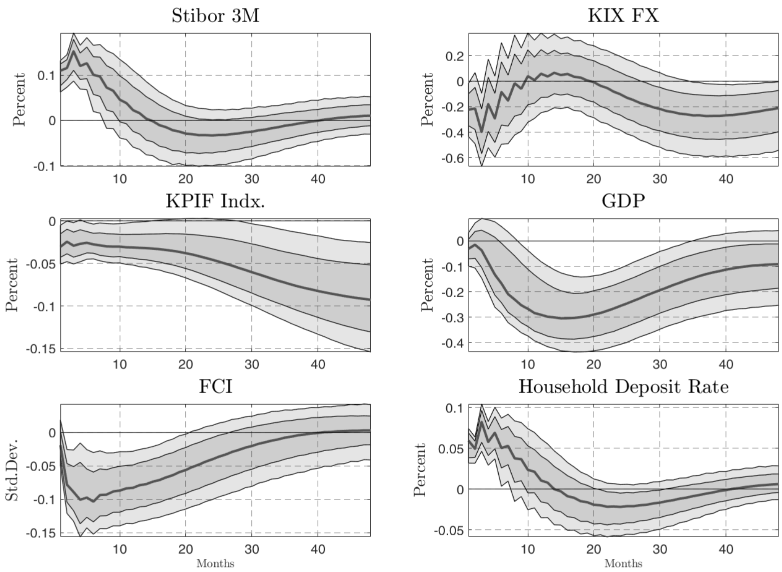
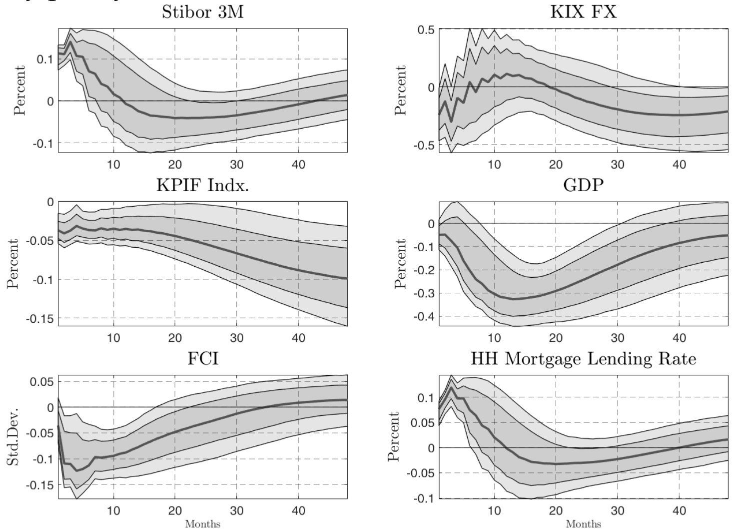
Note. Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). The monetary policy instrument are set to zero in October 2008. Frequentist VAR with Paul's exogenous proxy variable approach. Residual-based moving block bootstrap as in Lunsford and Jentsch (2016) is used to obtain confidence bands. The estimation sample is February 2000 to December 2019. The Bank OMX Index is the OMX Stockholm Banks PI (Macrobond series: sx8350pi) index. Units are in percent deviation, except the interest rate which is in terms of annual percentage rate (APR) and the FCI which is in terms of standard deviations.

Figure 22. Impulse responses of household deposit rate to a one standard deviation contractionary monetary policy shock.



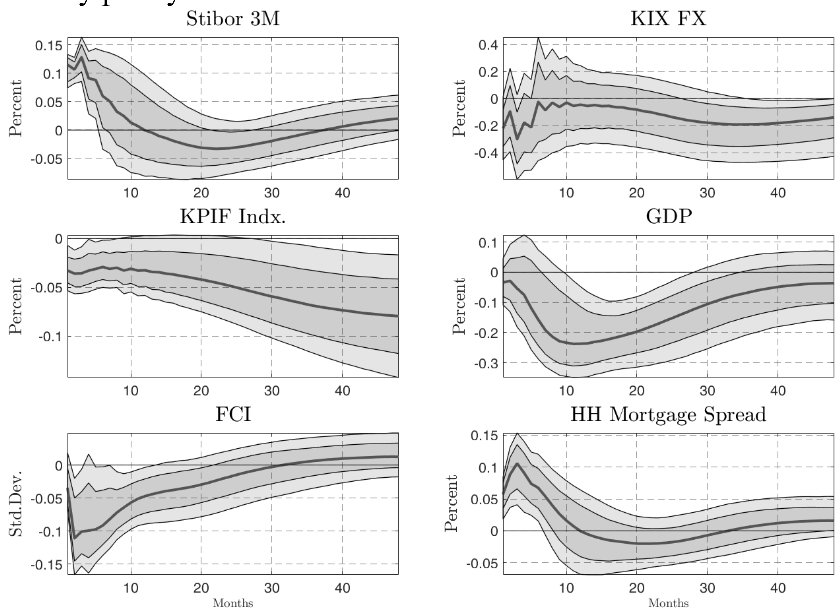
Note. Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). The monetary policy instrument are set to zero in October 2008. Frequentist VAR with Paul's exogenous proxy variable approach. Residual-based moving block bootstrap as in Lunsford and Jentsch (2016) is used to obtain confidence bands. The estimation sample is September 2005 to December 2019. The Household Deposit rates are banks' deposit rates, new agreements (percent) all accounts to households from table 8.4.1 in Statistics Sweden Financial Market Statistics. Since September 2005, the Riksbank is measuring average interest rate in SEK for deposits and loans from a sample of monetary financial institutions, every month. Between 2000 and September 2005 these measurements were done quarterly. The sample included a selection of banks and all the housing credit institutions. Units are in percent deviation, except the interest rates which are in terms of annual percentage rate (APR) and the FCI which is in terms of standard deviations.

Figure 23. Impulse responses of household mortgage lending rates to a one standard deviation contractionary monetary policy shock.



Note. Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). The monetary policy instrument are set to zero in October 2008. Frequentist VAR with Paul's exogenous proxy variable approach. Residual-based moving block bootstrap as in Lunsford and Jentsch (2016) is used to obtain confidence bands. The estimation sample is September 2005 to December 2019. The Household Mortgage Lending Rates are MFI, mortgage credit companies and AIFs' lending rates for housing loans, new agreements (percent) from table 8.1.1 in Statistics Sweden Financial Market Statistics. Since September 2005, the Riksbank is measuring average interest rate in SEK for deposits and loans from a sample of monetary financial institutions, every month. Between 2000 and September 2005 these measurements were done quarterly. The sample included a selection of banks and all the housing credit institutions. Units are in percent deviation, except the interest rates which are in terms of annual percentage rate (APR) and the FCI which is in terms of standard deviations.

Figure 24. Impulse responses of household mortgage spread to a one standard deviation contractionary monetary policy shock.



Note. Median (line), percentiles 16-84 (darker band), percentiles 5-95 (lighter band). The monetary policy instrument are set to zero in October 2008. Frequentist VAR with Paul's exogenous proxy variable approach. Residual-based moving block bootstrap as in Lunsford and Jentsch (2016) is used to obtain confidence bands. The estimation sample is September 2005 to December 2019. The mortgage spread is measured as the difference between MFI, mortgage credit companies and AIFs' lending rates for housing loans, new agreements (percent) from table 8.1.1 in Statistics Sweden and a Swedish 1 year benchmark government bond yield. Units are in percent deviation, except the interest rate and the mortgage spread which are in terms of annual percentage rate (APR) and the FCI which is in terms of standard deviations.

4. Conclusions

In this paper I address two intertwined questions. First, what is the nature and magnitude of the transmission mechanism is in Sweden and second, and possibly of broader interest, are central bank information shocks also a pervasive feature of market surprises when the central bank is highly transparent an reveals a large amount of information and reasoning regarding the interest rate decision?

To answer the first question I use the relatively recent innovation in dynamic causal inference namely “external instruments” in vector autoregressions (Stock and Watson 2012 and 2018, Mertens and Ravn 2013) to estimate the causal effects of exogenous monetary shocks on output, inflation, the exchange rate and financial conditions. To answer the second question I use a two-pronged approach to account for the possible presence of information frictions in Riksbank monetary policy announcements. The first approach follows Jarociński and Karadi (2020) and separates monetary policy shocks from contemporaneous information shocks by analyzing the high-frequency co-movement of interest rates and stock prices around the policy announcement. The second route in accounting for the possible presence of information frictions follows Miranda-Agrippino and Riccio (2020), who in turn build on Romer and Romer (2000), and define monetary policy shocks as shifts to the policy rate that are both unforeseen by market participants, and are not due to the central bank's concerns about either current or anticipated changes in economic conditions. What is novel in the way I implement this approach is not the method to control for the central bank's private information but the information that is being controlled for.

I find that a tightening of monetary policy has significant effects on the real economy, raising unemployment and depressing economic activity; as well as appreciating the domestic currency and inducing a reduction in CPIF-XE and tighter financial conditions. In an extended analysis I find that a monetary policy tightening leads to an increase of mortgage bond spreads, leading to a contraction in total credit and a fall in real house prices. I also find a significant and clear liquidity effect – an increase in nominal interest rates is accompanied by a fall in M1 and M3. I show that MFI lending rates to households are more responsive than deposit rates. These impulse responses provide support to the view monetary policy reduces the net worth and liquidity of borrowers which increases the effective cost of credit by more than the change in risk-free rates, thus intensifying the effect of the policy action. I find little or no support for the central bank information effect in Swedish data.

References

Adolfson, M., M. Andersson, J. Lindé, M. Villani, and A. Vredin, (2007): "Modern Forecasting Models in Action: Improving Macroeconomic Analyses at Central Banks," *International Journal of Central Banking*, pages 111-144, December.

Adolfson, M., S. Laseen, J. Lindé, and M. Villani, (2008): "Evaluating an estimated new Keynesian small open economy model," *Journal of Economic Dynamics and Control*, Elsevier, vol. 32(8), pages 2690-2721, August.

Alsterlind, J., M. Lindskog, and T. von Brömsen, (2020): “An index for financial conditions in Sweden”, Staff memo, February 2020.

Altavilla, C., L. Brugnolini, R. Gürkaynak, R. Motto, and G. Ragusa, (2019): "Measuring euro area monetary policy," *Journal of Monetary Economics*, Elsevier, vol. 108, pages 162-179, December.

Andersson, M., H. Dillen, and P. Sellin, (2006): "Monetary policy signaling and movements in the term structure of interest rates," *Journal of Monetary Economics*, Elsevier, vol. 53(8), pages 1815-1855, November.

Arias, J., J. Rubio-Ramirez, and D. Waggoner, (2018): "Inference Based on SVARs Identified with Sign and Zero Restrictions: Theory and Applications", *Econometrica* 86(2), pages 685–720

Barakchian, S., and C. Crowe, (2013): “Monetary policy matters: Evidence from new shocks data,” *Journal of Monetary Economics* 60(8), pages 950–966.

Bauer, M., and E. Swanson, (2020): "The Fed's Response to Economic News Explains the “Fed Information Effect”," Federal Reserve Bank of San Francisco Working Paper 2020-06.

Bernanke, B., M. Gertler, and M. Watson, (1997): “Systemic monetary policy and the effects of oil price shocks,” *Brookings Papers on Economic Activity*.

Björklund, M., M. Carlsson, and O. Nordström Skans, (2019): "Fixed-Wage Contracts and Monetary Non-neutrality." *American Economic Journal: Macroeconomics*, 11(2), pages 171-92.

Bjørnland, H., (2008): “Monetary policy and exchange rate interactions in a small open economy,” *Scandinavian Journal of Economics* 110(1), pages 197-221.

Bjørnland, H., (2009): “Monetary policy and exchange rate overshooting: Dornbusch was right after all,” *Journal of International Economics* 79(1), pages 64-77.

Bjørnland, H., and D. Jacobsen, (2013): “House Prices and Stock Prices: Different Roles in the US Monetary Transmission Mechanism,” *Scandinavian Journal of Economics*, Wiley Blackwell, vol. 115(4), pages 1084-1106, October.

Campbell, J. C., Evans, J. Fisher, and A. Justiniano, (2012) “Macroeconomic Effects of Federal Reserve Forward Guidance,” *Brookings Papers on Economic Activity*, 2012 (2012), 1–80.

Campbell, J., J. Fisher, A. Justiniano, and L. Melosi, (2016): “Forward Guidance and Macroeconomic Outcomes Since the Financial Crisis,” in NBER Macroeconomics Annual 2016, vol. 31: University of Chicago Press.

Cesa-Bianchi, A., G. Thwaites, and A. Vicondoa, (2020): “Monetary policy transmission in the United Kingdom: A high frequency identification approach,” *European Economic Review*, vol. 123, April 2020, 103375.

Cieslak, A. and A., Schrimpf, (2019) “Non-monetary news in central bank communication,” *Journal of International Economics*, vol. 118, pages 293-315.

De Rezende, R., (2017) “The interest rate effects of government bond purchases away from the lower bound,” *Journal of International Money and Finance*, Elsevier, vol. 74(C), pages 165-186.

Ellingsen, T., and U. Söderström, (2001): “Monetary Policy and Market Interest Rates,” *American Economic Review*, vol. 91(5), pages 1594-1607, December.

English, W., S. Van den Heuvel, and E. Zakrajšek, (2018): "Interest rate risk and bank equity valuations," *Journal of Monetary Economics*, Elsevier, vol. 98(C), pages 80-97.

Faust, J., J. Rogers, E. Swanson and J. Wright, (2003): “Identifying the Effects of Monetary Policy Shocks on Exchange Rates Using High Frequency Data.” *Journal of the European Economic Association*, vol. 1, No. 5, pages 1031-1057.

Faust, J., E. Swanson, and J. Wright, (2004): “Identifying VARs based on high-frequency futures data,” *Journal of Monetary Economics*, vol. 51, issue 6, pages 1107-1131.

Fransson, L., and O. Tysklind, (2016): “What effect does monetary policy have on interest rates?” *Economic Review* 2016:1, Sveriges Riksbank.

Hoesch, L., B. Rossi, and T. Sekhposyan, (2020): “Has the Information Channel of Monetary Policy Disappeared? Revisiting the Empirical Evidence”, CEPR Discussion Paper 14456.

Gertler, M., and P. Karadi, (2015): “Monetary Policy Surprises, Credit Costs, and Economic Activity,” *American Economic Journal: Macroeconomics,* 7(1), pages 44–76.

Goodhart, C., and B. Hofmann, (2008): “House prices, money, credit, and the macroeconomy,” *Oxford Review of Economic Policy*, vol. 24, no 1, pages 180–205.

Gürkaynak, R., B. Sack, and E., Swanson, (2005a): “The Sensitivity of Long-Term Interest Rates to Economic News: Evidence and Implications for Macroeconomic Models,” *American Economic Review*, pages 425-436.

Gürkaynak, R., B. Sack, and E. Swanson, (2005b): “Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements,” *International Journal of Central Banking*, vol. 1, pages 55-93.

Iacoviello, M., and R. Minetti, (2008): “The credit channel of monetary policy: evidence from the housing market”, *Journal of Macroeconomics*, vol. 30, no 1, pages 69–96.

Iacoviello, M., (2005): “House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle,” *American Economic Review*, vol. 95(3), pages 739-764, June.

Iversen, J., and O. Tysklind, (2017): “The effect of repo rate path changes on asset prices,” Staff memo, Sveriges Riksbank.

Jacobson, T., P. Jansson, A. Vredin, and A. Warne, (2002): “Identifying the Effects of Monetary Policy Shocks in an Open Economy,” Working Paper Series 134, Sveriges Riksbank.

Jarociński, M., and P. Karadi, (2020): “Deconstructing Monetary Policy Surprises—The Role of Information Shocks,” *American Economic Journal: Macroeconomics*, 12(2), pages 1-43.

Jordà, Ò., (2005): “Estimation and Inference of Impulse Responses by Local Projections,” *American Economic Review*, 95(1), pages 161-182.

Kuttner, K., (2001): “Monetary policy surprises and interest rates: Evidence from the Fed funds futures market.” *Journal of Monetary Economics* 47(3), pages 523–544.

Lakdawala, A., (2019): “Decomposing the effects of monetary policy using an external instruments SVAR,” *Journal of Applied Econometrics*, vol. 34, pages 934–950.

Laséen, S., and I. Strid, (2013): “Debt Dynamics and Monetary Policy: A Note,” Working Paper Series 283, Sveriges Riksbank.

Leeper, E., C. Sims, and T. Zha, (1996): “What Does Monetary Policy Do?,” *Brookings Papers on Economic Activity*, Economic Studies Program, The Brookings Institution, vol. 27(2), pages 1-78.

Lindé, J., M. Nessén, and U. Söderström, (2009): “Monetary policy in an estimated open-economy model with imperfect pass-through,” *International Journal of Finance and Economics*, pages 301-333.

Litterman, R., (1986): “Forecasting With Bayesian Vector Autoregressions - Five Years of Experience,” *Journal of Business and Economic Statistics*, pages 25-38.

Lunsford, K., and C. Jentsch, (2016): “Proxy SVARs: Asymptotic Theory, Bootstrap Inference, and the Effects of Income Tax Changes in the United States,” Federal Reserve Bank of Cleveland, Working Paper 1619.

Melosi, L., (2017): ”Signaling effects of monetary policy,” *The Review of Economic Studies* 84(2), pages 853–884.

Mertens, K., and M. Ravn, (2013): “The Dynamic Effects of Personal and Corporate Income Tax Changes in the United States,” *American Economic Review* 103(4), pages 1212–47.

Miranda-Agrippino, S., and G. Ricco, (2020): “The Transmission of Monetary Policy Shocks,” *American Economic Journal: Macroeconomics* (Forthcoming).

Musso, A., S. Neri, and L., Stracca, (2011): “Housing, consumption and monetary policy: How different are the US and the euro area?” *Journal of Banking & Finance*, Elsevier, vol. 35(11), pages 3019-3041, November.

Nakamura, E., and J. Steinsson, (2018): “High-Frequency Identification of Monetary Non-Neutrality: The Information Effect,” *The Quarterly Journal of Economics*, vol. 133, pages 1283-1330.

Paul, P., (2020): “The Time-Varying Effect of Monetary Policy on Asset Prices,” *The Review of Economics and Statistics,* October 2020, 102(4), pages 1–15.

Pescatori, A., and S. Laseen, (2020): “Financial Stability and Interest-Rate Policy; A Quantitative Assessment of Costs and Benefits,” *Canadian Journal of Economics*, vol. 53, Issue 3, pages 1246-1273.

Romer, D., and C. Romer, (2000): “Federal Reserve Information and the Behavior of Interest Rates," *American Economic Review*, vol. 90, pages 429-457.

Romer, C., and D. Romer, (2004): “A New Measure of Monetary Shocks: Derivation and Implications,” *American Economic Review*, vol. 94(4), pages 1055–1084.

Samuelsson P., (1945): “The Effect of Interest Rate Increases on the Banking System,” *The American Economic Review*, vol. 35, No. 1, pages 16-27.

Sandström, M., (2018): “The impact of monetary policy on household borrowing - a high-frequency IV identification,” Working Paper Series 351, Sveriges Riksbank.

Stock, J., J. Wright, and M. Yogo, (2002): “A survey of weak instruments and weak identification in generalized method of moments,” *Journal of Business & Economic Statistics* vol. 20(4), pages 518–29.

Stock, J., and M. Watson, (2010): “Research Memorandum,” https://www.princeton. edu/~mwatson/mgdp_gdi/Monthly_GDP_GDI_Sept20.pdf.

Stock J, and M. Watson, (2012): “Disentangling the Channels of the 2007-2009 Recession,” Brookings Papers on Economic Activity. 2012, Spring 2012, pages 81-135.

Stock, J., and M. Watson, (2018): “Identification and Estimation of Dynamic Causal Effects in Macroeconomics Using External Instruments,” *The Economic Journal*, vol. 128, pages 917-948.

Villani, M., and A. Warne, (2003): “Monetary policy analysis in a small open economy using Bayesian cointegrated structural VAR’s,” Sveriges Riksbank Working Paper Series 156.

Walentin, K., (2014): “Business Cycle Implications of Mortgage Spreads,” *Journal of Monetary Economics*, vol. 67, pages 62–77.

Appendix

A. Data construction and sources

I use the following data series in the benchmark VARs:

Variable	Construction and source
Sweden, Interbank Rates, STIBOR, 3 Month, Fixing	Monthly average. Source: Nasdaq OMX
Sweden, FX Indices, Riksbanken, KIX Index	100×log(x) where x is a monthly average. Source: Sveriges Riksbank.
Sweden, Inflation, Underlying Inflation CPIF Excluding Energy, Index	100×log(x). x is first seasonally adjusted with x-12 method. Source: Statistics Sweden
Sweden, Gross Domestic Product, Total, Constant Prices, SA, Market Prices, SEK.	100×log(x). I disaggregate real GDP from quarterly to monthly frequency following the state space method outlined in Bernanke, Gertler, and Watson, (1997) Appendix A. See also Stock and Watson (2010). I use the unemployment rate, The Economic Tendency Indicator and the Consumer confidence indicator as monthly indicators. Results are not sensitive to also including industrial production and service production as monthly indicators. Source: Statistics Sweden and NIER.
Sweden, Financial Conditions Index	Source: Alsterlind, Lindskog and von Brömsen (2020).

The surprise component of the change in the Swedish repo rate Δr_t^s, is given by

$$\Delta r_t^s = \frac{(d1+d2)}{d2}(S_t^1 - S_{t-\Delta t}^1), \qquad \text{(B1)}$$

where $(S_t^1 - S_{t-\Delta t}^1)$ is the change in the 1-month OIS interest rate around a window of fifteen minutes before and two hours and forty five minutes after each monetary policy announcement, $d1$ is the number of days between the day the 1-month OIS contract takes effect and the repo rate implementation day, and $d2$ is the number of days within the repo rate implementation day and the day in which the contract ends.

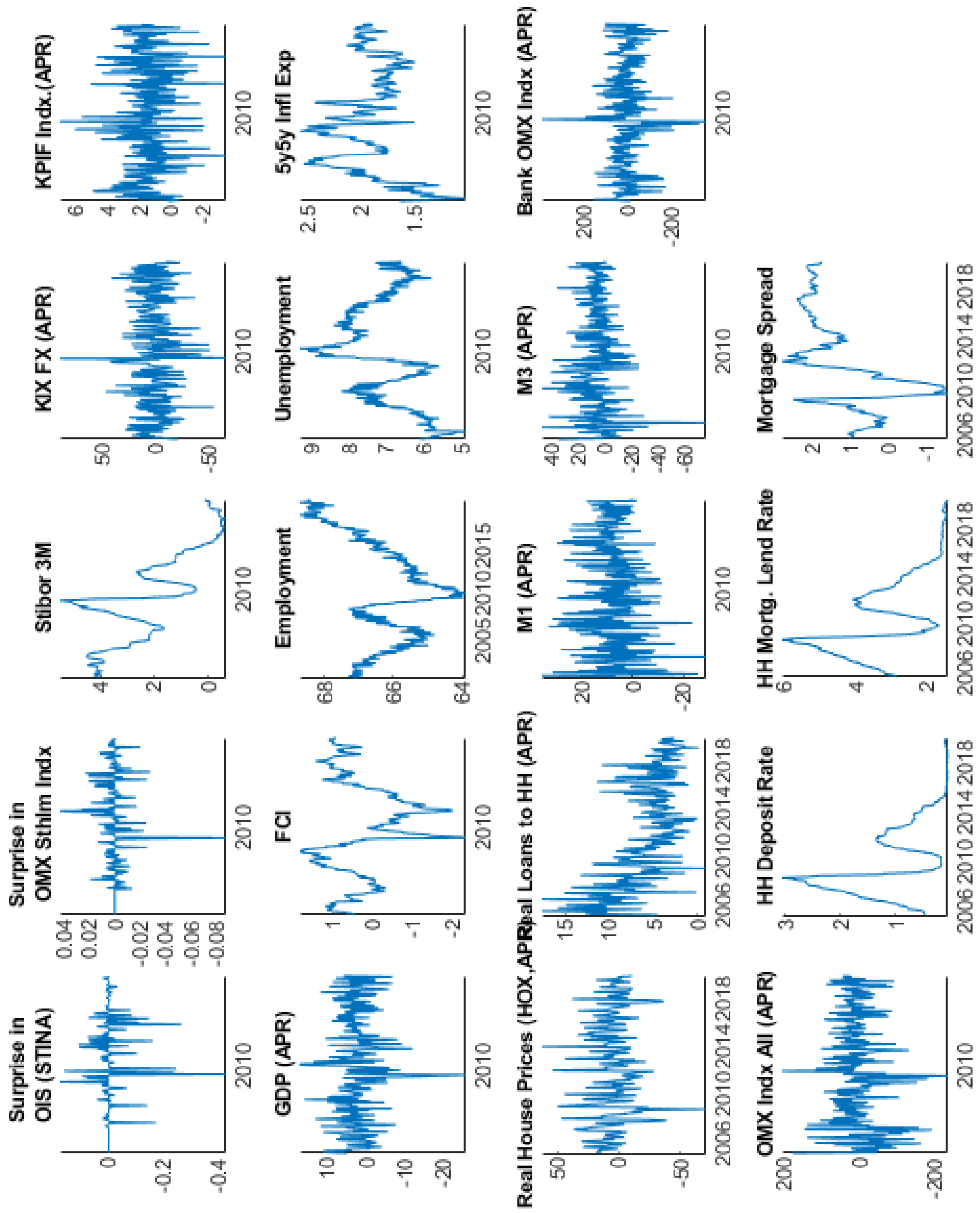
I the additional analysis I augment the benchmark VAR with the following variables:

Variable	Construction and source
Sweden, Employment rate and Unemployment rate	15-74 years. Seasonally adjusted series Available since January 2001. Source: Statistics Sweden, Labour Force Survey.
Sweden, 5-Year, 5-Year Forward Inflation Expectation Rate	Source: Sveriges Riksbank
Sweden, Real Estate Prices, HOX, Valueguard, Residential, Price Index	100×log(x) where x is deflated with CPIF excluding energy. Source: Valueguard Sweden AB
Sweden, Loans to Swedish Households	100×log(x) where x is deflated with CPIF excluding energy. x is a growth index, MFI:s' lending to households from Table 4.1.2 in Financial Market Statistics. Source: Statistics Sweden
Sweden, Money Supply (M1 and M3)	100×log(x) where x is either M1 or M3 which have been seasonally adjusted. M1 is equal to the sum of notes and coins held by the Swedish non-bank public + on-demand deposits. M2 is equal to the sum of M1 + deposits redeemable at a notice of up to 3 months or deposits with a term to maturity of up to and including 2 years. M3 is equal to the sum of M2, repurchase agreements and the non-bank public's holdings of shares in money market funds and interest-bearing securities, with a term to maturity of up to and including 2 years. Source: Statistics Sweden.
Sweden, Equity Indices, Nasdaq OMX, ICB Sector, Banks, Index, Price Return, SEK and	100×log(x) where x is a monthly average. Macrobond names: omxspi and sx8350pi. Source: Nasdaq OMX.

Equity Indices, Nasdaq OMX, All-Share, OMX Stockholm Index, Price Return SEK.	
Sweden, Household deposit rates, Mortgage lending rate and Mortgage Spread.	The Household Deposit rates are banks' deposit rates, new agreements (percent) all accounts to households from table 8.4.1 in Statistics Sweden Financial Market Statistics. The Household Mortgage Lending Rates are MFI, mortgage credit companies and AIFs' lending rates for housing loans, new agreements (percent) from table 8.1.1 in Statistics Sweden Financial Market Statistics. The mortgage spread is measured as the difference between MFI, mortgage credit companies and AIFs' lending rates for housing loans, new agreements (percent) from table 8.1.1 in Statistics Sweden and a Swedish 1 year benchmark government bond yield.

The forecasts that accompany the Riksbank monetary policy announcements were taken from the Riksbank's webpage https://www.riksbank.se/en-gb/monetary-policy/monetary-policy-report/. I use the Swedish version of the xlsx-files which contain the numerical data from the reports between 2007 and 2019. CPIF forecasts are available from 3 July 2008. I use the CPIX inflation forecasts in the reports published on 19 December 2007 and on 13 February 2008 and the UND1X inflation forecasts in the first three reports of 2007.

Figure A1. Data



Note. See tables above for definitions, transformation and sources. Units are in terms of annual percentage rate (APR) except the labor market variables which are in percent and the financial conditions index (FCI) which is in terms of standard deviations.

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