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EFFECTIVENESS OF MONETARY POLICY IN SWEDEN

RICHILD MOESSNER, JAKOB DE HAAN and DAVID-JAN JANSEN*

We study whether the sensitivity of Swedish interest rates to domestic economic news was affected by the zero lower bound (ZLB) and forward guidance. We find that the sensitivity was reduced at the ZLB at short but not at longer maturities, suggesting that monetary policy remained effective at longer horizons. Moreover, it was unaffected during a later period of the ZLB/negative policy rates, suggesting that monetary policy remained effective at all horizons then. We also find that the sensitivity of interest rates to domestic news was unaffected by forward guidance, suggesting that market participants understood the conditionality of the forward guidance. (JEL E52, E58)

I. INTRODUCTION

In several countries, including Sweden, the monetary authorities reduced policy rates to (levels close to) zero to counter the economic downturn due to the recent financial crisis, and in some cases subsequently even reduced them below zero. The first contribution of the article is that we examine whether the monetary policy of Sveriges Riksbank (Sweden's central bank) was still effective under the zero lower bound (ZLB). Even when policy rates are at the ZLB, monetary policy may still be effective through unconventional policies, such as asset purchase programs and liquidity support, and communication on the forward path of policy rates. As long-term rates are more relevant for economic decisions than the current level of the overnight rate, any action by the central bank that

influences interest rate expectations could be a potential tool for monetary policy, even if current short-term rates cannot be reduced any further (Blinder et al. 2008; Eggertsson and Woodford 2003; Rudebusch and Williams 2008; Swanson and Williams 2014a).

In Sweden, the Riksbank's most important policy rate, the repo rate, was at the effective ZLB of 25 basis points between July 8, 2009 and July 6, 2010 (see Figure 1). Several years later, the repo rate was reduced to 0%, on October 29, 2014, and subsequently became negative, falling to -10 basis points on February 18, 2015, to -25 basis points on March 25, 2015, and to -35 basis points on July 8 2015.¹ As to unconventional policy, the Riksbank provided banks extensive liquidity support by offering loans in Swedish kronor at longer maturities, and started purchasing government bonds in 2015.

Recently, Swanson and Williams (2014a, 2014b) investigated the effectiveness of monetary policy when policy rates are (close to) zero. They estimate the time-varying sensitivity of yields to macroeconomic news (i.e., unexpected developments of some macroeconomic variable) using daily data, and compare that sensitivity to a benchmark period in which the ZLB was not a concern. If a particular yield is

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1. See <http://www.riksbank.se/en/Interest-and-exchange-rates/Repo-rate-table/>.

ABBREVIATIONS

CPI: Consumer Price Index
GDP: Gross Domestic Product
PPI: Producer Price Index
QE: Quantitative Easing
ZLB: Zero Lower Bound

FIGURE 1
Riksbank's Repo Rate (in Percent)

Source: Riksbank Monetary Policy Reports October 2013 and July 2015.

about as sensitive to news as in the benchmark sample, monetary policy is unconstrained. In contrast, if the yield responds very little or not at all to news, it is largely or completely constrained. We study whether the sensitivity to economic news of short- to long-term interest rates implied by interest rate swaps in Sweden was affected by the ZLB of the policy rate. Following Swanson and Williams (2014a, 2014b), we interpret the sensitivity of interest rates to economic news as a measure of the effectiveness of monetary policy at the ZLB (see also Moessner 2014).

Since 2007, Sveriges Riksbank has published its policy-rate forecasts as part of the bank's inflation-targeting strategy. The Riksbank was among the first central banks to implement this practice. Only the Reserve Bank of New Zealand (since 1997) and Norges Bank, the central bank of Norway (since 2005) were earlier. Also these central banks are inflation targeters.² Communication on the future path of policy rates is also known as forward guidance (Bernanke and Reinhart 2004). The published policy-rate forecasts of the Riksbank are conditional on current insights about future economic developments.

Although inflation targeting central banks have always emphasized that their policy-rate guidance is conditional on economic developments, rather than an unconditional commitment, several central bankers noted that market participants may not sufficiently

appreciate the conditionality of these forecasts (cf. Issing 2005; Kohn 2005).

The second contribution of this article is that we address the concern that financial markets may not understand the conditionality of the quantitative forward guidance provided by the Riksbank. Following Moessner and Nelson (2008), we examine whether market reactions to macroeconomic news change when forward guidance is provided. We interpret a reduction in the sensitivity of interest rate swaps to domestic economic news with the introduction of policy-rate forecasts as evidence that financial market participants do not understand the conditionality of the guidance and focus on it too much.

Sweden is an interesting country for studying the effects of the ZLB and forward guidance. It is one of three inflation-targeting countries that regularly publish *quantitative* forecasts of the policy rate by the body taking decisions on monetary policy. This is in contrast to the qualitative forward guidance of the Federal Reserve, the Bank of England, the European Central Bank (ECB), the Bank of Japan, and the Bank of Canada which has been investigated intensively in previous research (see, for instance, Fay and Gravelle 2009; Moessner and Nelson 2008; Swanson and Williams 2014b).³ When studying changes in the interest rate sensitivity to macroeconomic news at the ZLB, Swanson and Williams (2014a, 2014b) only considered central banks providing qualitative forward guidance (i.e., the Federal Reserve, the Bank of England, and the ECB), not quantitative forward guidance as we do in this article. When studying changes in the interest rate sensitivity to macroeconomic news, also Moessner and Nelson (2008) and Fay and Gravelle (2009) only considered a country providing qualitative forward guidance (the United States and Canada, respectively). The conditionality of forward guidance may be better understood for regularly published quantitative policy-rate forecasts than for infrequently provided qualitative forward guidance.

The outline of the article is as follows. Section II offers a discussion of monetary policy options in times of crisis, of forward guidance and the issue of its conditionality, and briefly describes

2. The number of inflation-targeting central banks has increased over time as shown by Samaryna and de Haan (2014). However, only three of these central banks publish the policymakers' forecasts of the policy rate.

3. Other central banks (such as the Czech National Bank and the Central Bank of Iceland) publish projections of the staff of the central bank, while the Fed publishes target federal funds rate projections by Federal Reserve Board members and Federal Reserve Bank presidents without assigning projections by name. However, as these are not forecasts by the decision-making committee they do not constitute forward guidance.

the Riksbank's policies during the financial crisis. Section III presents the data, Section IV presents the estimation method and discusses the results, while Section V concludes.

II. BACKGROUND

A. *Policy Options under the ZLB*

The 2007–2009 global financial crisis was not the first time that policy rates were closing in on the ZLB. In the early 2000s, short-term interest rates were close to, or at zero, in a number of countries, including Japan, the United States, and Switzerland (Bernanke, Reinhart, and Sack 2004). Therefore, the options available for monetary policy at the ZLB have been discussed for some time in the literature. The starting point is that long-term interest rates are more relevant for consumption and investment decisions than the current level of the policy rate. Therefore, not only the current level of the policy rate, but also the entire path of expected future rates determines the effect of monetary policy on the economy. The key insight, then, is that any central bank action that influences interest rate expectations could be a potential tool for monetary policy, even if current short-term rates cannot be reduced any further. The available policy actions include communication and asset purchases (Ball 2015; Bernanke, Reinhart, and Sack 2004; Blinder et al. 2008; Eggertsson and Woodford 2003; Swanson and Williams 2014a).

First, communication by the central bank may affect expectations of the path of expected interest rates. Blinder et al. (2008) discuss how signals by the central bank may affect interest rate expectations. By implication, even when the policy rate can no longer be reduced, there is still a possibility for the monetary policy authority to influence long-term interest rates through this expectations channel (Bernanke and Reinhart 2004; Swanson and Williams 2014a). Eggertsson and Woodford (2003) show that by committing to future monetary accommodation once the ZLB ceases ("low for longer"), the central bank can circumvent the ZLB to be binding.

In practice, central banks have emphasized that their policy-rate guidance at the ZLB is not a commitment, but that it is conditional on economic developments. For example, the Federal Reserve stated that it "anticipates" that interest rates will remain unchanged through 2014, but it did not give a promise. The Bank of Canada made its forward guidance conditional

on the outlook for inflation (Carney 2012). As expectations about the economic outlook change, partly because of the publication of macroeconomic news, expectations about the central bank's future policy rates will change, in turn affecting longer-term market interest rates; consequently, longer-term market interest rates can continue to respond to macroeconomic news under the ZLB (Moessner 2014). Such policy-rate guidance could increase the understanding by market participants of the central bank's reaction function to economic news.

Second, central banks may use unconventional monetary policies, in the form of asset purchases and/or liquidity support to banks. Asset purchases by the central bank may influence long-term yields. These purchases can take two forms. On one hand, the central bank may attempt to change the composition of private sector portfolios. The effects of the former strategy hinges on the degree to which different asset classes are seen as substitutes by investors (Bernanke and Reinhart 2004). D'Amico and King (2013) provide evidence that the Federal Reserve's purchases of U.S. treasuries in 2009 have had an effect on yields, suggesting imperfect substitution. On the other hand, monetary policy authorities could expand the size of the central bank's balance sheet. This strategy of quantitative easing (QE) could be effective if money is an imperfect substitute for other financial assets, or if QE changes expectations of future interest rates (Bernanke and Reinhart 2004). Liquidity support could also reduce the level of short-term rates or spreads in the interbank money market. This reduction of levels or spreads through injections of additional liquidity may have a positive effect on aggregate demand (Joyce, Tong, and Woods 2011; Lenza, Pill, and Reichlin 2010; Pattipeli et al. 2013).

As expectations about the economic outlook change, partly due to incoming macroeconomic news, the expected size of a central bank's QE program can change, which can in turn affect longer-term bond yields. Longer-term bond yields can therefore continue to respond to macroeconomic news at the ZLB of the policy rate via this channel (Swanson and Williams 2014b).

Swanson and Williams (2014a) present an illustrative small New Keynesian model for the effect of the ZLB on the sensitivity of market interest rates to macroeconomic news, in the absence of forward guidance and QE. Monetary policy is modeled as a Taylor rule with the constraint that the one-period nominal interest

rate is nonnegative. Long-term interest rates in the model are assumed to be determined by the expectations hypothesis. This model shows that the ZLB leads to a reduction in the reaction of market interest rates of all maturities to macroeconomic news, that is, unexpected developments of some macroeconomic variables. The reduction is greatest at short maturities, but smaller at longer maturities. This is the case since first, there is a total lack of responsiveness at the shortest maturity to an economic news shock when the ZLB is binding, and second, longer-term interest rates are an average of expected future short-term interest rates, and at some time in the future short-term interest rates are expected not to be constrained by the ZLB anymore, as policy rates are expected to be normalized. At the ZLB longer-term market interest rates can continue to respond to macroeconomic news due to QE and forward guidance, as discussed above. The first contribution of our article is that we examine whether monetary policy of the Riskbank was still effective at the ZLB.

B. Forward Guidance and Conditionality

Forward guidance has been classified into “Delphic forward guidance” and “Odyssean forward guidance” by Campbell et al. (2012), with Delphic forward guidance defined as merely forecasting macroeconomic performance and likely monetary policy actions, which could affect private sector expectations if the central bank is perceived to have superior forecasting ability or better knowledge about its own monetary policy intentions. By contrast, Odyssean forward guidance is defined as publicly committing the central bank to future monetary policy action. Under this classification, regularly publishing interest rate forecasts under inflation targeting, as done by the Riksbank, falls under Delphic forward guidance. Such Delphic forward guidance is time consistent, in contrast to Odyssean forward guidance, which involves commitment and is time inconsistent.

In practice, central banks have emphasized that policy-rate guidance is conditional on economic developments, rather than an unconditional commitment. However, prior to the crisis, central bankers frequently noted that market participants may not appreciate sufficiently the conditionality and uncertainty of central banks’ policy-rate forecasts, so that they could impair informational efficiency, with financial markets placing too much weight on central bank

forecasts, reducing their own analysis of economic developments (cf. Issing 2005; Kohn 2005).

Moessner and Nelson (2008) investigated this concern for a pre-crisis period of qualitative forward guidance by the Federal Reserve. They found that financial market participants understood the conditionality of the forward guidance, and continued to pay close attention to macroeconomic news during the period when the Federal Open Market Committee was providing guidance on future policy rates. Fay and Gravelle (2009) find that qualitative forward guidance by the Bank of Canada in the form of the publication of forward-looking policy statements starting in July 2004 reduced the sensitivity of Canadian market interest rates to domestic macroeconomic news. They suggest that this could be due to market participants’ insufficient understanding of the conditionality of the forward guidance, even though it was stated to be conditional on economic developments by the Bank of Canada.

Our second contribution is that we investigate whether financial markets understand the conditionality of the quantitative forward guidance provided by the Riksbank since 2007. Using the approach of Moessner and Nelson (2008), we examine whether market reactions to macroeconomic news change when forward guidance is provided. Since the Riksbank is an inflation-targeting central bank, it responds to domestic economic news, and we therefore consider changes in market reactions to domestic economic news. If market participants would interpret forward guidance as unconditional, that is, as a commitment to keep interest rates at a particular level, changing economic circumstances would not affect their expectations about future policy rates. Under those conditions, market interest rates will not react to macroeconomic news. A reduction in the sensitivity of interest rate swaps to economic news with the introduction of forward guidance would therefore provide evidence that financial market participants do not understand the conditionality of the guidance and focus on it too much.

Some previous studies analyzed the policies of the other two central banks publishing their policy-rate forecasts, that is, New Zealand and Norway. Moessner and Nelson (2008) analyzed the effects of the Reserve Bank of New Zealand’s published interest rate forecasts. Although they find evidence that central bank policy-rate forecasts influence market prices in New Zealand, they find no evidence that market participants

systematically overweight policy-rate guidance or that they do not appreciate the uncertainty and conditionality of it. Detmers and Nautz (2012) studied policy-rate forecasts in New Zealand also in the wake of the crisis. They confirm for the pre-crisis period that the Reserve Bank of New Zealand's interest rate forecasts were an efficient tool for guiding market expectations for short-term horizons, but find for the post-crisis period that the role of interest rate forecasts for futures rates has decreased significantly. Andersson and Hofmann (2010) find weak evidence for New Zealand that the publication of an interest rate path could enhance the central bank's leverage over medium-term interest rates. Holmsen et al. (2008) conclude for Norway that financial markets appear to understand that the interest rate path published by Norges Bank is conditional on economic developments.

There is no clear agreement in previous work on the effectiveness of the Riksbank's forward guidance. Kool and Thornton (2012) investigate the effectiveness of forward guidance for the central banks of four countries, including Sweden. For Sweden, they find evidence that forward guidance improved market participants' ability to forecast short-term rates over short forecast horizons. Beechey and Österholm (2012) find that the forecast accuracy of survey-based and market-based private sector policy-rate expectations has improved since the Riksbank started publishing its own policy-rate forecasts. However, according to Woodford (2012), the Riksbank's forward guidance was not so successful, as market participants' expectations were often not in line with projected policy rates. The empirical evidence of Goodhart and Rochet (2011) suggests that Swedish money market rates at longer horizons do not react to the surprise component in the official policy-rate path. This finding would indicate that the projected repo path at longer horizons adjusts to market rates, rather than the other way round.

C. Swedish Monetary Policy during the Crisis

During the crisis years, Swedish monetary policy makers used a combination of policy tools. The Riksbank reduced interest rates sharply, so that the repo rate was close to the ZLB between July 2009 and July 2010 (see Figure 1). Several years later, the repo rate was reduced to 0%, on October 29, 2014, and subsequently became negative, falling to −10 basis points on February 18, 2015, to −25 basis points on March 25, 2015,

and to −35 basis points on July 8, 2015. The Riksbank also continued its quantitative forward guidance on the policy rate, by publishing forecasts of its policy rate, which it had introduced in 2007. It also continued to describe its policy-rate forecasts occasionally in its press statements accompanying the policy-rate decisions, as it had already done away from the ZLB. For example, in July 2009, the Riksbank reduced the policy rate to 0.25%, and indicated that “the repo rate is expected to remain at this low level until autumn 2010.”⁴ The Riksbank also conducted unconventional monetary policy through liquidity assistance. The first loans were granted in October 2008, and after that loans were offered regularly until the end of October 2010 (Elmér et al. 2012). The Riksbank's unconventional monetary policy measures also included offering loans to counterparties in U.S. dollars and approving a wider range of securities as collateral (Andersen 2012; Elmér et al. 2012; Ingves 2012). Asset purchase programs were not used before 2015. In February 2015, the Riksbank announced that it would buy SEK 10 billion government bonds in order to make monetary policy even more expansionary. It announced its decisions to buy an additional SEK 30 billion, SEK 40–50 billion, and SEK 45 billion of government bonds in March, April, and July 2015, respectively.

III. DATA

We use daily data on interest rate swaps with maturities of 1, 2, 5, and 10 years between June 1, 1998 and July 31, 2015 from Bloomberg. We use market interest rates implied by the interest rate swaps market due to its liquidity. Figure 2 shows the development in swap rates over the sample period. One- and two-year swap rates remained positive during the first period of the effective ZLB from July 2009 to July 2010, but turned negative in early 2015 as policy rates became negative.

The surprises of the real-time macroeconomic data releases are calculated relative to Bloomberg median survey expectations, and are normalized by their standard deviation over the period June 1998 to June 2012. The following macroeconomic indicators for Sweden are included: consumer price index (CPI) inflation, producer price index (PPI) inflation, the unemployment

4. An overview of these repo announcements is available at: <http://www.riksbank.se/en/Monetary-policy/Forecasts-and-interest-rate-decisions/Previous-repo-rate-decisions/>.

rate, retail sales, consumer confidence, gross domestic product (GDP), industrial production, and the trade balance.

The series for Swedish survey data for CPI inflation is available almost every month from the start of the sample period in June 1998, with missing values only in 5 months prior to 2002, and no missing values from 2002. But the other series for Swedish survey data either start later and/or exhibit missing values. These gaps occurred when Bloomberg received fewer than three survey responses for a particular indicator in a particular month. Consequently, Bloomberg did not publish summary statistics for that indicator and month, since they would

Williams (2014a, 2014b) and Moessner and Nelson (2008), we regress daily changes in interest rate swaps with maturities of $m = 1, 2, 5$, and 10 years, $y^m(t) - y^m(t-1)$, in basis points, on the normalized surprise components of U.S. and domestic economic data releases, $sur_j^{US}(t)$ and $sur_j^d(t)$, respectively, and interact the right-hand side variables with a dummy variable for the first period of the ZLB of the policy rate, $dum_{ZLB1}(t)$, with a dummy variable for the second period of the ZLB/negative policy rates, $dum_{ZLB2}(t)$, and with a dummy variable for the period when the Riksbank provided forward guidance, $dum_{FG}(t)$. The regression takes the form

$$(1) \quad y^m(t) - y^m(t-1) = c + (c_{ZLB1} * dum_{ZLB1}(t) + c_{ZLB2} * dum_{ZLB2}(t) + c_{FG} * dum_{FG}(t)) \\ + \sum_{j=1}^{n^{U.S.}} a_j * sur_j^{U.S.}(t) (1 + f_{ZLB1} * dum_{ZLB1}(t) + f_{ZLB2} * dum_{ZLB2}(t) + f_{FG} * dum_{FG}(t)) + \\ + \sum_{j=1}^{n^d} b_j * sur_j^d(t) (1 + g_{ZLB1} * dum_{ZLB1}(t) + g_{ZLB2} * dum_{ZLB2}(t) + g_{FG} * dum_{FG}(t)) + \varepsilon_t,$$

not be meaningful. In the following, we therefore present regression results when only CPI inflation surprises are included as Swedish data, and regression results when all Swedish indicators are included. Bloomberg survey expectations have frequently been used to calculate macroeconomic data surprises in the recent literature, see for example, Gürkaynak, Levin, and Swanson (2006) for Sweden.

For small open economies like Sweden, U.S. macroeconomic news generally affects market interest rates, in addition to domestic economic news. For example, U.S. macroeconomic news tended to move Canadian bond yields more than domestic macroeconomic news before the Bank of Canada announced the dates of its policy meetings in advance in November 2002 (Gravelle and Moessner 2002). We therefore control for the impact of U.S. macroeconomic news on Swedish market interest rates. The 11 U.S. macroeconomic indicators used are listed in Table 1.

IV. METHOD AND RESULTS

A. Main Results

We consider the effects of the ZLB and forward guidance on the interest rate sensitivity to economic news. Following Swanson and

where the superscript d refers to domestic Swedish data, n^d is the number of domestic macroeconomic indicators, and $n^{U.S.} = 11$ is the number of U.S. macroeconomic indicators included in the regression. The coefficient b_j is the estimated response, in basis points, of interest rate swap rates to a one standard deviation surprise in Swedish economic news outside the ZLB

FIGURE 2
Swedish Interest Rate Swaps (in Percent)

Source: Bloomberg.

TABLE 1

Effect of ZLB and Forward Guidance on Reactions of Swedish Interest Rate Swaps to Domestic Economic News

	1 Year	2 Years	5 Years	10 Years
c	-0.02	0.01	0.01	-0.01
c_{ZLB1}	0.26	0.19	-0.09	-0.24
c_{ZLB2}	-0.12	-0.11	-0.01	0.02
c_{FG}	-0.18	-0.19	-0.15	-0.08
U.S. nonfarm payrolls	1.57***	1.87***	2.47***	2.15***
U.S. ISM	1.31***	1.74***	2.13***	2.21***
U.S. unemployment rate	-0.38	-0.23	-0.59	-0.60
U.S. retail sales	0.68*	1.25**	1.41***	1.42***
U.S. industrial production	1.25***	1.35***	1.14***	0.97***
U.S. housing starts	0.10	-0.16	-0.12	0.11
U.S. CPI	0.25	0.37	0.33	0.62*
U.S. PPI	-0.49*	-0.23	-0.12	0.03
U.S. hourly earnings	1.00**	1.34***	1.76***	1.66***
U.S. trade	0.90**	1.27***	0.86**	0.52
U.S. GDP (advance)	-0.61	-0.50	-0.51	-0.25
Swedish CPI	2.37***	2.78***	1.79***	0.84*
Swedish PPI	0.55*	0.40	0.33	0.03
Swedish unemployment rate	-0.87***	-1.16***	-0.81**	-0.51*
Swedish retail sales	0.69**	0.84**	0.43	0.20
Swedish consumer confidence	0.12	0.53	0.30	0.09
Swedish GDP	0.72	1.01	0.80	0.37
Swedish industrial production	0.69**	1.03***	0.50	0.29
Swedish trade balance	-0.02	0.17	0.50	0.42
g_{ZLB1} (on Swedish data surprises)	-0.69**	-0.85**	-0.65	-1.86
[p value of Wald test that $g_{ZLB1} = -1$]	[0.2669]	[0.6546]	[0.5463]	[0.5064]
g_{ZLB2} (on Swedish data surprises)	0.28	-0.12	-0.23	-1.23
[p value of Wald test that $g_{ZLB2} = -1$]	[0.0000]	[0.0016]	[0.2436]	[0.8966]
g_{FG} (on Swedish data surprises)	-0.11	0.12	0.38	1.10
[p value of Wald test that $g_{FG} = -1$]	[0.0000]	[0.0000]	[0.0042]	[0.0668]
Adjusted R^2	0.035	0.044	0.031	0.023
No. of obs.	4,422	4,434	4,443	4,443

Notes: Newey–West adjusted standard errors. Sample period: June 1, 1998 to July 31, 2015. ISM, Institute of Supply Management.

***, **, and * represent significance at the 1%, 5%, and 10% level, respectively.

and guidance periods. A significantly negative estimate of g_{ZLB1} and g_{ZLB2} would indicate reduced responsiveness during the first period of the effective ZLB and the second period of the ZLB/negative policy rates, respectively. As pointed out, a reduced sensitivity would suggest that monetary policy would be less effective at the ZLB. A significantly negative estimate of g_{FG} would indicate reduced responsiveness during the guidance period. Swanson and Williams (2014a, 2014b) and Moessner and Nelson (2008) assume that the coefficients on the dummy variables for the ZLB and forward guidance, respectively, are identical for all kinds of economic news, and we follow their approach. Swanson and Williams (2014b, 7) justify this assumption as follows: “Intuitively, if a Treasury security’s sensitivity to news is reduced because its yield

is starting to run up against the zero bound, then we expect that security’s responsiveness to all macroeconomic data releases to be damped by a roughly proportional amount.” Swanson and Williams (2014b) test this assumption, and find that it is very consistent with the data. The regression is estimated using nonlinear least squares, because the regressions are nonlinear in the parameters, and this method allows us to determine significance levels for the changes in reactions to macroeconomic news. We use Newey–West adjusted standard errors to correct for heteroskedasticity and serial correlation.

The Executive Board’s decision to cut the repo rate to 0.25% was announced on July 2, 2009, and its decision to increase the repo rate to 0.5% was announced on July 1, 2010. Since efficient market prices incorporate news at the

time of its announcements, we define the dummy variables $dum_{ZLB1}(t)$ and $dum_{ZLB2}(t)$ based on the announcement dates of the repo rate changes. The dummy variable $dum_{ZLB1}(t)$ takes on the value of one from July 2, 2009, the day the repo rate cut to 0.25% was announced, to June 30, 2010, the day before the repo rate increase to 0.5% was announced, and zero otherwise. The dummy variable $dum_{ZLB2}(t)$ takes on the value of one from October 27, 2015, the day the repo rate cut to 0% was announced, until the end of the sample period on July 31, 2015, and zero otherwise. The dummy variable $dum_{FG}(t)$ takes the value of one after February 15, 2007 when the Riksbank started publishing forecasts of its policy rate, and is zero otherwise.

The results for Equation (1) when all Swedish ($n^d = 8$) and U.S. macroeconomic indicators are included are shown in Table 1. At all maturities, the surprises concerning U.S. and Swedish data have the expected sign when they are significant (except for U.S. PPI at the 1-year maturity). CPI inflation surprises have the largest coefficient among the Swedish indicators and are significant at the 1% or 10% level at all maturities.

The results suggest that the sensitivity of interest rate swaps to Swedish macroeconomic news is reduced by around 70%–85% during the first period of the effective ZLB from July 2009 to July 2010 for the shorter maturities of 1 and 2 years, at the 5% significance level, but is unaffected at the longer maturities of 5 and 10 years. We also find that the sensitivity to domestic macroeconomic news of interest rates at all maturities is unaffected during the second period of the ZLB/negative policy rates from October 2014 to July 2015 (the end of the sample period). These results suggest that monetary policy remained effective at the ZLB at longer horizons in Sweden during the first period of the ZLB. This could be due to the forward guidance by the Riksbank, which was already in place before the height of the global financial crisis with the collapse of Lehman Brothers, as well as unconventional monetary policy measures mentioned above. Our results also suggest that monetary policy remained effective at all horizons during the second period of the ZLB/negative interest rates. In addition to the Riksbank's forward guidance and unconventional monetary policy measures, this could be due to market expectations that there was room for the policy rate to be reduced further into negative territory. In contrast to the first effective ZLB period, where market participants thought that the policy rate would

remain positive, these results suggest market participants thought that during the second period of the ZLB/negative policy rates, the policy rate would not be stuck at a lower bound of zero, but could be cut further below zero, as in the case of the Swiss National Bank where the policy rate was cut to –75 basis points. This possibility is illustrated by comments by Thomas Jordan, president of the Swiss National Bank, that “minus 75 basis points is not the absolute bottom, but it's also the case that under normal circumstances you get to a point where people say they'd prefer to hold cash” (Jordan 2015). It is also reflected in the fact that 1- and 2-year Swedish inflation swap rates became negative during the second period of the ZLB/negative policy rates (see Figure 2).

The results of Table 1 also show that the sensitivity of interest rate swaps to Swedish macroeconomic news is not significantly affected at any maturity by the Riksbank's forward guidance. This implies that market participants did not reduce their attention to Swedish macroeconomic news, which suggests that they understood the conditionality of the Riksbank's policy-rate forecasts and did not take them as unconditional commitments. Our empirical approach compares the reactions of market interest rates to macroeconomic news in the period prior to the introduction of forward guidance with that in the period after the introduction of forward guidance. This approach allows determining whether the introduction of forward guidance caused market participants to focus less on economic news, misinterpreting the forward guidance as unconditional. We do not estimate the direct effects of forward guidance announcements on market interest rates, but of the introduction of forward guidance on the sensitivity of market interest rates to macroeconomic news. Our finding that the introduction of forward guidance had no effect on the sensitivity of market rates to economic news does not imply that the forward guidance announcements had no direct effects on market rates. In our approach, we do not consider the time profile of the market reactions to macroeconomic news between the publication dates of different policy-rate forecasts, as in Detmers and Nautz (2014). These authors estimate, for the case of New Zealand, the time profile of market reactions to macroeconomic news between the publication dates of different policy-rate forecasts, relative to the market reactions to the publication of the policy-rate forecasts. They examine the time-varying and state-dependent effects of interest rate projections on market expectations and

uncertainty using an EGARCH model, and find a stabilizing effect of new central bank announcements of their interest rate projections. They conclude that individual forward guidance announcements were useful in managing market expectations, but that they can become “stale” sometime after their release. These results are consistent with our finding that market participants understand the conditionality of the forward guidance, as market interest rates react to macroeconomic news in anticipation of the publication of the new forward guidance. Ehrmann and Sondermann (2012) investigate the time profile of market reactions to macroeconomic news between the publications of different Inflation Reports of the Bank of England and compare it with the market reactions to the publication of the Inflation Reports. Since this study was conducted before the Bank of England introduced forward guidance in 2013, it analyzes the effects of the publication of macroeconomic forecasts (of growth and inflation), rather than of policy-rate guidance. They find that the relative importance of macroeconomic news rises between two releases of Inflation Reports.

The results for Equation (1) when only surprises concerning Swedish CPI inflation ($n^d = 1$) are included along with news about U.S. macroeconomic indicators are shown in Table A1 in the Appendix. Similar to the findings as reported in Table 1, the sensitivity of interest rate swaps to Swedish CPI inflation surprises is reduced by around 60%–70% during the first period of the effective ZLB from July 2009 to July 2010 for maturities of 1 and 2 years, but now at the 10% significance level, and it is unaffected at the longer maturities of 5 and 10 years. Also as in Table 1, we again find that the sensitivity to Swedish CPI inflation surprises of interest rates at all maturities is unaffected during the second period of the ZLB/negative policy rates from October 2014. We can also see that the sensitivity of interest rate swaps to domestic macroeconomic news continues not to be significantly affected at any maturity by the Riksbank's forward guidance, as in Table 1.

We also report results of Wald tests for the null hypothesis that the coefficients of the dummy variables interacted with macroeconomic data surprises are equal to -1 , for each of the regressions performed above, in the respective tables (Tables 1 and A1). A coefficient of -1 would imply that the reactions to macroeconomic news have been completely attenuated. The most striking result is that we can reject at the 10% level

in almost all cases that the coefficient of the dummy variable for forward guidance interacted with Swedish data surprises is equal to -1 . The only exception is for g_{FG} on Swedish CPI inflation surprises for the regression of Table A1 for the 10-year maturity, where a value of -1 cannot be rejected at conventional significance levels, although the p value is small (p value of 0.11). For the coefficient of the dummy variable for the first period of the ZLB interacted with Swedish data surprises, we cannot reject a value of -1 at the 10% level in any of the cases. This is consistent with finding a significantly negative value for g_{ZLB1} for Swedish data surprises in the regressions of Tables 1 and A1 for the 1- and 2-year maturities, and partly reflects large standard errors for the 5- and 10-year maturities, for which g_{ZLB1} is not significantly negative.

B. Robustness Tests

Among international macroeconomic news, U.S. data as considered above tend to be most important for international market interest rates. As a robustness check, we also consider euro area and UK macroeconomic data surprises, in addition to U.S. data surprises, in Equation (1). The surprises are again calculated with respect to median Bloomberg survey expectations using real-time data releases, normalized by their standard deviation. The macroeconomic indicators considered for the euro area are euro area CPI inflation, the German Ifo business climate index, the German Centre for European Economic Research expectations survey, the European Commission euro area consumer confidence indicator, French business confidence manufacturing industry sentiment index (INSEE [National Institute of Statistics and Economic Studies]), the euro area unemployment rate, the German unemployment rate, euro area GDP, euro area retail sales, German retail sales, German industrial production, German manufacturing orders, euro area M3 annual growth rate, German CPI inflation, and German PPI inflation, based on Brière and Ielpo (2007). The macroeconomic indicators for the United Kingdom are retail price index (excluding mortgages) inflation, average earnings, monthly changes in unemployment, retail sales, PPI inflation, GDP, industrial production, the current account balance, the trade balance in goods, and the public sector net cash requirement, based on Gravelle, Moessner, and Sinclair (2005).

The results with all Swedish indicators are shown in Table 2, and those with Swedish CPI

TABLE 2

Coefficients on Dummy Variables Interacted with Swedish Macronews, all Swedish and International News

		1 Year	2 Years	5 Years	10 Years
<i>Zero lower bound and forward guidance</i>	g_{ZLB1} (on Swedish data surprises)	-0.71**	-0.84**	-0.55	-1.73
	g_{ZLB2} (on Swedish data surprises)	0.32	-0.06	-0.11	-1.01
	g_{FG} (on Swedish data surprises)	-0.12	0.09	0.32	0.99

Notes: Newey–West adjusted standard errors. Sample period: June 1, 1998 to July 31, 2015.

** represents significance at the 5% level.

only among the Swedish data are shown in Table A2 in the Appendix. The main results are very similar to those obtained in the main specification in Table 1 above. The sensitivity of interest rate swaps to domestic economic news continues to be reduced during the first period of the effective ZLB for the shorter maturities of 1 and 2 years, but not for the longer maturities of 5 and 10 years, again both when all Swedish indicators are included, and when only Swedish CPI is included. Moreover, the sensitivity of interest rate swaps to domestic economic news continues to be unaffected at any maturity by the second period of the ZLB/negative policy rates. Furthermore, forward guidance continues to have no significant effect on the sensitivity of interest rate swaps to domestic economic news, both when all Swedish indicators are used and when only Swedish CPI is included.

V. CONCLUSIONS

We study whether the sensitivity of Swedish interest rates to economic news was affected by the zero lower bound. We interpret the sensitivity of longer-term yields to economic news as a measure of the effectiveness of monetary policy. We find that the sensitivity of interest rate swaps to Swedish macroeconomic news was reduced at the effective ZLB from July 2009 to July 2010 at short maturities of 1 and 2 years, but not at longer maturities of 5 and 10 years. This suggests that monetary policy remained effective (in

the sense that monetary policy has an impact on the yield curve) at the ZLB at longer horizons in Sweden. This could be due to forward guidance by the Riksbank, which was already in place before the height of the global financial crisis, as well as unconventional monetary policy measure. Moreover, we find that the sensitivity of both shorter- and longer-term interest rates to this news did not decline during the second period of the ZLB/negative policy rates from October 2014 to July 2015, suggesting that monetary policy remained effective at all horizons. In addition to the Riksbank's forward guidance and unconventional monetary policy measures, this could be due to expectations that there was room for the policy rate to be reduced further into negative territory.

We also study whether the sensitivity of Swedish interest rates to economic news was affected by the Riksbank's forward guidance. We interpret a reduction in the sensitivity of interest rate swaps to domestic economic news with the introduction of forward guidance as evidence that financial market participants do not understand the conditionality of the guidance. We find that the sensitivity of interest rate swaps to Swedish macroeconomic news was not significantly affected by forward guidance. This implies that market participants did not reduce their attention to Swedish macroeconomic news, which suggests that they understood the conditionality of the Riksbank's policy-rate forecasts, and did not take them as unconditional commitments.

APPENDIX

TABLE A1

Effect of the Zero Lower Bound and the Riksbank's Forward Guidance on Reactions of Swedish Interest Rate Swaps to Swedish CPI News

	1 year	2 years	5 years	10 years
c	0.00	0.02	0.02	0.00
c_{ZLB1}	0.27	0.20	-0.08	-0.24
c_{ZLB2}	-0.08	-0.06	0.02	0.04
c_{FG}	-0.19	-0.21	-0.16	-0.09
U.S. nonfarm payrolls	1.57***	1.86***	2.46***	2.14***
U.S. ISM	1.31***	1.74***	2.13***	2.20***
U.S. unemployment rate	-0.37	-0.23	-0.60	-0.61
U.S. retail sales	0.68*	1.25**	1.42***	1.44***
U.S. industrial production	1.28***	1.40***	1.19***	1.01***
U.S. housing starts	0.09	-0.17	-0.12	0.11
U.S. CPI	0.25	0.38	0.33	0.62*
U.S. PPI	-0.49*	-0.22	-0.12	0.05
U.S. hourly earnings	1.00**	1.34***	1.75***	1.65***
U.S. trade	0.88**	1.25***	0.83*	0.50
U.S. GDP (advance)	-0.59	-0.51	-0.52	-0.28
Swedish CPI	2.63***	3.14***	2.11***	1.07*
g_{ZLB1} (on Swedish CPI surprises)	-0.57*	-0.68*	-0.77	-1.11
[p value of Wald test that $g_{ZLB1} = -1$]	[0.1582]	[0.4039]	[0.7106]	[0.9244]
g_{ZLB2} (on Swedish CPI surprises)	0.22	-0.10	-0.52	-1.98
[p value of Wald test that $g_{ZLB2} = -1$]	[0.0000]	[0.0003]	[0.3303]	[0.5466]
g_{FG} (on Swedish CPI surprises)	-0.30	-0.11	0.11	0.61
[p value of Wald test that $g_{FG} = -1$]	[0.0004]	[0.0003]	[0.0144]	[0.1092]
Adjusted R^2	0.03	0.04	0.03	0.02
No. of obs.	4,422	4,434	4,443	4,443

Notes: Newey–West adjusted standard errors. Sample period: June 1, 1998 to July 31, 2015. ISM, Institute of Supply Management.

***, **, and * represent significance at the 1%, 5%, and 10% level, respectively.

TABLE A2

Coefficients on Dummy Variables Interacted with Swedish CPI News, all US, Euro Area, and UK Indicators

	1 year	2 years	5 years	10 years
<i>Zero lower bound and forward guidance</i>				
g_{ZLB1} (on Swedish CPI surprises)	-0.57*	-0.71*	-0.78	-1.18
g_{ZLB2} (on Swedish CPI surprises)	0.25	-0.07	-0.47	-1.91
g_{FG} (on Swedish CPI surprises)	-0.28	-0.09	0.11	0.66

Notes: Newey–West adjusted standard errors. Sample period: June 1, 1998 to July 31, 2015.

* represents significance at the 10% level.

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