The effects of monetary policy on interest rates

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In this article, we analyse the transmission mechanism for monetary policy in Sweden by studying how different interest rates in the economy move when the repo rate is adjusted. In our analysis, we note that most interest rates covary with the repo rate. This relationship is clearest for shorter market rates, which is a consequence of that the Riksbank can use the repo rate to control the very shortest interest rates in the economy. Longer market rates, which are affected by the development of international interest rates and various risk premiums to a greater extent, also show relatively high covariation with the repo rate. The repo rate also has a close relationship with interest rates for households and companies. Our analysis demonstrates that these interest rates are normally adjusted in line with repo rate adjustments.

Introduction

Using its monetary policy, the Riksbank is able to influence the economy through several different channels. One important channel lies through various interest rates in the economy, both interest rates determined on financial markets and interest rates faced by households and companies in the form, for example, of interest rates for mortgages. The Riksbank’s most important instrument for governing these interest rates is the repo rate. For example, when the repo rate is cut, both market rates and end rates for households and companies usually also drop. When mortgage rates fall, those households with mortgages have more money left for other purposes and may then choose to consume a greater amount of other goods and services. In addition, the lower interest rates make it cheaper to borrow and less advantageous to save, which also leads households to consume more. In a similar way, lower interest rates make it cheaper for companies to invest. A lower repo rate thus stimulates demand in the economy, eventually leading to prices being raised and the rate of inflation thereby rising. The way that monetary policy affects the economy is usually called the monetary policy transmission mechanism. Understanding this mechanism is an important part in decision-making for both central banks and participants on the financial markets.1

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1 For a complete description of the transmission mechanism, see Sveriges Riksbank(2009).
In this article, we examine more closely the way in which different interest rates are affected by changes to the repo rate. We start by describing the theoretical relationship between the repo rate and other interest rates in the economy by explaining how repo rate changes spread to different financial markets and how different participants may act. We go on to examine how the repo rate and different interest rates in the economy have covaried in recent years. Finally, we make a quantitative analysis of how different interest rates change in conjunction with monetary policy decisions and use these results to study the effects of the monetary policy decision from March 2015.

We will demonstrate that most interest rates in the economy follow the repo rate relatively well. The link is clearest for interest rates with short maturities but also interest rates with longer maturities are adjusted when the repo rate changes. We will also demonstrate that there is a clear link between the repo rate and the interest rates faced by households and companies. Our studies show that these interest rates fluctuate approximately in line with changes to the repo rate.

How monetary policy affects the general level of interest rates

The repo rate is the Riksbank’s primary monetary policy instrument. Using the repo rate, the Riksbank is able to steer the interest rate on the overnight market, which is to say the interest rate for loans between banks from one day to the next. The Riksbank can also use its forecast of the repo rate to give a clear signal of what the overnight rate may be in the period ahead. Using these two tools, the Riksbank can also influence other interest rates in the economy.2

SWEDISH MONETARY POLICY

As the repo rate forms the starting point for this analysis, in this section we will first briefly describe Swedish monetary policy in recent decades.

Since January 1993, the Riksbank has had the target of achieving stable prices, which has been described as a rate of inflation of 2 per cent, measured as the annual percentage change in the Consumer Price Index (CPI). This decision was taken after the transition to a floating exchange rate at the end of 1992, when the fixed krona exchange rate could no longer be defended. Since the Riksbank introduced its inflation target, the rate of inflation has been significantly lower than before, which has also led to a lower repo rate. A relatively long period of stable growth combined with low inflation was noted until the middle of the first decade of this century.3 This period came to an end when the global financial crisis broke out in 2008. Like many other central banks, the Riksbank cut its policy rate to close to zero during the financial crisis. Since then, many central banks have maintained a low policy rate due to a weak recovery and the dampened development of

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2 For a more detailed description of the framework for the implementation of monetary policy, see, for example, Sveriges Riksbank (2011).
3 See, for example, Ingves (2015).
inflation. The Riksbank raised the repo rate to 2 per cent in 2010-2011, when the economy recovered strongly but then started to cut the repo rate again towards the end of 2011 when the economic outlook for the euro area deteriorated and inflationary pressures dropped. Since February 2015, the repo rate has been negative and, in addition, the Riksbank has made its monetary policy even more expansionary through the purchase of government bonds.  

**HOW DOES THE RIKSBANK CONTROL THE INTEREST RATES?**

The market for balancing liquidity overnight – also known as the overnight market – is the market in which banks manage temporary surpluses and deficits in their liquidity in Swedish kronor. The need for an overnight market arises due to the payments in Swedish kronor handled by the banks every day. Payments in Swedish kronor between banks are made via transfers between their accounts in the Riksbank’s payment system RIX. The Riksbank sets the terms and conditions for the banks’ deposits and loans through these accounts. The interest rate the banks pay or receive on their accounts in RIX forms the so-called interest-rate corridor, which is linked to the repo rate.

At the end of every day, the banks must consider how to fund their deficit or deposit their surplus. For the sake of simplicity, let take, as an example, a bank with a liquidity surplus that must be deposited. The bank will then have several different alternatives. The first alternative is to deposit the money in its account in RIX at the repo rate minus 0.75 percentage points. However, the bank can probably receive a higher interest rate by lending the money overnight to another bank that has a deficit and that would instead have had to borrow in RIX at the repo rate plus 0.75 percentage points. The banks then agree on an interest rate closer to the repo rate, and it is this rate that forms the overnight rate. The bank could also choose to lend money for longer maturities, say three months. Slightly simplified, it is more advantageous for the bank to lend the money for three months if it is expected to give a higher risk-adjusted return than if the money is regularly deposited overnight for three months. Demand for this kind of investment will then increase and its pricing will be adjusted until the expected risk-adjusted return is the same for both alternatives. Consequently, the interbank rate with a three-month maturity should be equivalent to the expected average overnight rate over the given period adjusted for credit

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4 For more information on the Riksbank’s complementary measures, see, for example, the Monetary Policy Report from February and Economic Commentaries nos. 11, 12 and 13 (2015).

5 In addition to depositing or borrowing money in RIX, the Riksbank offers weekly transactions at a rate equal to the repo rate. If the banking system has a deficit towards the Riksbank, this is met by the execution of a repo transaction by the Riksbank (which is to say the Riksbank purchases securities). If the banking system instead needs to deposit, the Riksbank issues Riksbank Certificates. At present, the banking system as a whole needs to deposit money in the Riksbank. The Riksbank also implements fine-tuning operations every day to stabilise the overnight rate. This is achieved by the bank system as a whole being able to borrow or deposit in the Riksbank, normally at the repo rate plus/minus 0.1 of a percentage point, depending on whether there is an overall surplus or deficit towards the Riksbank at the end of the day. As a result, the overnight rate is kept inside a band that is narrower than the interest-rate corridor.

6 The relationship between price and rate for a bond is such that, when the price rises, the expected yield falls and thus so does the rate.
and liquidity risks. This is in line with the so-called expectations hypothesis, which, put briefly, says that longer interest rates are determined by expectations of the future short rate. If the Riksbank, by using the repo rate and the repo rate path, can influence the market’s view of the overnight rate in the coming period, it can also largely steer the three-month interbank rate.

The Riksbank can also affect other to short-term rates applied to other participants, such as repos, deposit and lending rates and treasury bills. In addition, banks and other participants have the possibility of depositing the money in various types of security, such as government, mortgage and corporate bonds. According to the expectations hypothesis, the price and thereby the yield of these securities should also be adjusted so that the risk-adjusted yields for the various types of asset are the same. This means that, if the rate on the interbank market should fall, for example, it will become more attractive to invest in the other asset types, all other factors being equal. The price of the other assets will then increase, meaning that the rate will fall, until the participants again regard the various alternatives as equally attractive.

This reasoning can also be applied to longer maturities. That is to say that the risk-adjusted yield on an asset with a maturity of, for example, one year should correspond to the expected risk-adjusted yield on an asset that is reinvested every third month at a rate with a maturity of three months. The difference in the rate between different asset types with the same maturity should then reflect different risk profiles for the different asset types, such as credit and liquidity risks, for example. By steering the current overnight rate between the banks and signalling its future level, the Riksbank can, to a certain extent, steer most nominal interest rates in the economy (see Figure 1).

Figure 1. The transmission mechanism – from the repo rate to interest rates for households and companies

LONGER INTEREST RATES ARE INFLUENCED BY SEVERAL FACTORS

The longer we come from the overnight rate in both maturity and asset type, the more the asset’s price is affected by an increasing number of factors that the Riksbank cannot influence. Prices for assets with longer maturities are largely governed by international developments, which means that Swedish market rates with longer maturities follow the international interest rate situation to a large extent. The primary reason for this is that Sweden, which is a small, open economy, is affected by global economic activity and monetary policy. In the long run, this means that Swedish interest rates tend to covary

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7 An example of a repo is when an actor needs a specific security for a relatively short period of time and borrows this from another participant in return for money. The party borrowing the security then pays interest on it in proportion to the repo rate.
with foreign interest rates. In addition, over the long term, interest rates both in Sweden and abroad can be expected to return to the level of interest rates prevailing in a normal economic situation.

As most of the interest-bearing assets and liabilities held by Swedish households and companies are bank-related, it is also important to understand how fluctuations in market rates impact on the banks’ deposit and lending rates to households and companies. Like other interest rates in the economy, the banks’ deposit and lending rates should be influenced by changes in the repo rate and repo rate path. The competition between the banks should result in changes in market rates and thus changes in the banks’ funding costs also having an impact on end customers such as companies and households.

**MOST INTEREST RATES COVARY WITH THE REPO RATE**

A first step in analysing how the repo rate affects the interest rate situation in Sweden is to carry out a study of how different interest rates have historically covaried with the repo rate. Figure 2 shows the repo rate, together with the interbank rate Stibor with two different maturities, T/N and three-month, and the rate for a three-month treasury bill. T/N stands for tomorrow/next, which is the overnight rate the banks offer each other on loans from tomorrow until the next day. It is the shortest rate available in official statistics. Stibor with a maturity of three months is the interest rate that the banks offer each other for investments three months ahead, while the treasury bill represents the interest rate that the government pays for its short-term borrowing with a maturity of three months. In Figure 2, we can see that these interest rates follow each other fairly well. Since 2000, the correlation between the repo rate and Stibor T/N has been almost 1 and, for three-month interest rates, the correlation lies between 0.97 and 0.98 (see Table 1). It is also worth noting that the gap between the interbank rates, above all those for three months, and the repo rate increased during the financial crisis of 2008-2009 before then becoming entrenched on a slightly higher level for a longer period. But this gap has closed again recently. The widening gap between the interest rates during the crisis can be explained by increased uncertainty on the interbank market, which reduced liquidity and led the banks to demand a higher premium for lending money to each other. However, calculations of correlation indicate that the correlation between the interest rates has not changed notably since the financial crisis (see Table 1) All in all, the first stage of the monetary policy transmission mechanism thus seems to work well, as the short-term interest rates largely follow the repo rate.

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8 The Riksbank’s payment system RIX contains transaction data for the actual overnight rate from 2007. For a more detailed description of this data, see, among others, Sveriges Riksbank (2011). In general, Stibor T/N has moved close to the overnight rate but has, in periods, demonstrated a slightly higher level of volatility.
Interest rates with longer maturities do not have such a strong connection to the repo rate. Figure 3 shows the repo rate together with the rate for a five-year government bond, mortgage bond and a swap rate with an equivalent maturity. It can also be seen in this illustration that the different rates follow each other, but that the covariation is not as close as it is for rate with shorter maturities, which is also reflected in the correlation. Since 2000, the repo rate and the longer rates have had a correlation of between 0.54 and 0.70 (see Table 1). This is to be expected, as rates with a longer maturity are steered by the expected future repo rate to a greater extent than they are by the current repo rate. In addition, rates with longer maturities are affected by premiums that compensate for the uncertainty surrounding the future level of the repo rate. As Sweden is a small and open economy, these rates also follow the level of interest rates abroad.

As we have previously discussed, the difference in interest rates between different asset types with the same maturity should only be due to the difference in risk from asset to asset. As we see in Figure 3, interest rates with five-year maturities follow each other well, but the difference between them varies slightly over time. This is clearest for the period during the financial crisis that started in 2008. During this period, there was great uncertainty over the situation in the Swedish banking sector, as illustrated by the larger gap between mortgage bonds and the government and swap rate. The gap has since closed and is now at approximately the same level as prior to the financial crisis. However, calculations of correlation indicate that the correlation with the repo rate has decreased slightly since 2008 (see Table 1).

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A swap is a derivative instrument whereby two parties agree to exchange interest rate flows over a predetermined period. Usually, a fixed interest rate is exchanged for a variable interest rate and, in this contract, the fixed interest rate that the parties have agreed upon forms a swap rate.
Finally, we can study how well deposit and lending rates to households and companies follow the repo rate. Figure 4 shows the repo rate and the average deposit and lending rate for households and non-financial corporations respectively since 2005. These rates also seem to follow the repo rate closely and, since 2005, the correlation has been close to 1 for all rates (see Table 1). However, a shift is visible in the diagram in conjunction with the financial crisis, as the difference between the repo rate and the deposit rate decreased, at the same time as the difference between the lending rate and the repo rate increased. This is because the banks have wished to avoid negative deposit rates and consequently did not cut rates when the repo rate approached zero. As a relatively large part of the banks’ funding comes from deposits, we deem that this has also had a certain effect on lending rates since the banks want to maintain their margins. However, the correlation with the repo rate has not decreased since 2008.
Table 1. Correlation between the repo rate and various interest rates in the economy

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Stibor, T/N</td>
<td>0.99</td>
<td>0.99</td>
</tr>
<tr>
<td>Stibor, 3 months</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td>Treasury bill, 3 months</td>
<td>0.97</td>
<td>0.96</td>
</tr>
<tr>
<td>Government bond yield, 5 years</td>
<td>0.54</td>
<td>0.42</td>
</tr>
<tr>
<td>Mortgage bond yield, 5 years</td>
<td>0.61</td>
<td>0.50</td>
</tr>
<tr>
<td>Swap rate, 5 years</td>
<td>0.70</td>
<td>0.67</td>
</tr>
<tr>
<td>Lending rate, household</td>
<td>0.96</td>
<td>0.96</td>
</tr>
<tr>
<td>Lending rate, corporate</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td>Deposit rate, household</td>
<td>0.99</td>
<td>0.99</td>
</tr>
<tr>
<td>Deposit rate, corporate</td>
<td>0.99</td>
<td>0.99</td>
</tr>
</tbody>
</table>

Note. The correlation has been calculated using series adjusted for a linear trend.

Quantitative analysis of how the repo rate affects the general level of interest rates

As the analysis shows, there is a clear covariation between the repo rate and other interest rates. The relationship is stronger for shorter rates than it is for longer rates. However, using only the covariation between the interest rates, it is not possible to draw the conclusion that it is the repo rate that steers the other rates. The covariation could, in principle, have other explanations. Consequently, to develop our analysis, we take the step of studying how interest rates react in conjunction with a repo rate decision. We do this by using a regression analysis, in which we estimate how repo rate changes affect other interest rates in the economy. In this section, we start by explaining the model we use. We then describe
the data used and thereafter report our results. Finally, we use these results to analyse interest rate movements in conjunction with the monetary policy decision from March 2015.

**MARKET RATES SHOULD ONLY REACT TO UNEXPECTED REPO RATE CHANGES**

As we have described previously, monetary policy influences the general level of interest rates partly via changes to the repo rate, but also by steering expectations of future monetary policy. In theory, financial markets are forward-looking, which means that all available information should be reflected in the asset price. This hypothesis also says that market rates should continually be adjusted when expectations of future monetary policy are changed, for example with the publication of new data. This constant adjustment of financial markets makes it difficult to capture the effects of monetary policy on financial instruments. However, one way may be to examine fluctuations in conjunction with a monetary policy decision. In theory, then, market rates should only be adjusted if the decision was unexpected, while expected decisions should already be reflected in the price. A central stage of our analysis will thereby be to distinguish between expected and unexpected repo rate changes.

In many studies, the effects of monetary policy on the economy are studied by using monthly or quarterly data, as higher frequency macroeconomic statistics are not available. However, pricing on financial markets is adjusted constantly. To separate the effects of monetary policy from other events that also influence pricing on financial markets, we use daily data. To do this, we study the daily changes in various interest rates for the days on which monetary policy decisions are published.

**MONETARY POLICY EXPECTATIONS CAN BE MEASURED BY USING ‘STINA’ CONTRACTS**

Studies made on data from the United States and elsewhere show that it is difficult to capture the effect of monetary policy on other interest rates if expected and unexpected interest rate adjustments cannot be separated. Unlike earlier studies, Kuttner (2001), for example, shows that US monetary policy has a significant effect on different interest rates in the economy when expected and unexpected policy rate adjustments are separated. However, to do this, it must be possible to measure monetary policy expectations, even though they are not directly observable. For example, Kuttner uses forward contracts for the US policy rate as an instrument to measure expectations of the US policy rate.

There are two main methods that can be used to measure expectations for the repo rate – the pricing of financial derivatives and survey-based expectations. The Swedish equivalent of the instruments used by Kuttner are RIBA futures (Riksbank futures), which are forward contracts with the repo rate as an underlying asset\(^{10}\). However, using these instruments to

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\(^{10}\) A RIBA is a type of forward contract whereby two parties agree on an interest rate at a point in the future. The time interval and the price (interest rate) in the contract are determined when the contract is entered into and will depend to a great extent on the counterparties’ interest rate expectations. RIBA contracts refer to future repo rate levels.
measure monetary policy expectations in Sweden is not without problems. These contracts have only existed since 2009 and the maturity of the shortest available contract is three months, which means that it often covers several monetary policy meetings.

To measure monetary policy expectations, we instead use another derivative contract traded on the Swedish fixed-income market, a so-called interest rate swap. An interest rate swap can, for example, be used by a company that has a variable-rate loan, but which wishes to avoid uncertainty as regards possible future interest rate changes. The company may then enter into an agreement with another party that undertakes to pay the company’s variable interest rate, in exchange for which the company pays an agreed fixed interest rate for the period covered by the agreement.

The swap contract with the shortest maturities is called the Stina contract (Stockholm Tomorrow Next Interbank Average) and exists with maturities ranging from one month to one year. A Stina contract is an agreement to pay or receive the difference between a fixed interest rate and a variable interest rate, with the Stibor T/N as underlying asset. The contract thus does not reflect direct expectations of the repo rate, which may be a problem as Stibor T/N is linked with a certain risk premium that can vary over time. However, in Figure 3, we can see that these interest rates mostly follow each other well. In this study, we will therefore use the Stina contract with a maturity of one month to measure the monetary policy expectations ahead of a monetary policy decision.

An alternative to market-based expectations is provided by questionnaire-based surveys, in which market actors are asked what they expect the repo rate to be following the next monetary policy meeting. The greatest advantage of such surveys is that they are simple and directly reflect market participants’ expectations. But there are also certain disadvantages. These include the surveys normally being carried out some time before the monetary policy meeting, meaning that expectations may have changed by the time the meeting takes place. In addition, surveys have difficulty capturing probabilities for different outcomes, as the respondents probably state their mode forecasts but not the level of uncertainty linked with them. This is to say that, if the respondent, for example, cannot decide between a repo rate adjustment and an unchanged rate but finally chooses one, this choice would be a mode forecast and would be included in the survey.

Another favourable characteristic of Stina contracts is that they do not have any co-called counterparty risk, as OMX stands as guarantor, which is to say that there is no risk linked to the counterparty to the agreement failing to fulfil its commitments - OMX assumes these commitments in that case. Neither do Stina contracts have any credit risk, as settlement occurs on final payment day, which is to say that the parties make no initial payment but rather that the difference between the variable and fixed interest rates is calculated on payment date, after which payment is made. These characteristics should lead to low risk premiums in Stina listings.
HOW CAN EXPECTED AND UNEXPECTED REPO RATE ADJUSTMENTS BE DIFFERENTIATED?

As we have already mentioned, Stina contracts have Stibor T/N as underlying asset and, normally, these interest rates lie close to each other but can, in certain periods, separate. As the difference varies over time, this can lead to the measure of expectations becoming misleading when longer time horizons are examined. To avoid this, we calculate the surprise component as the difference in the Stina contract over a short period before and after the repo rate decision.\(^\text{12}\) The Stina contract reflects an average of the expected interest rate over the coming month. However, as the new repo rate is implemented on the first Wednesday after the monetary policy decision, the number of days that the new repo rate level affects the contract will vary from announcement to announcement. Consequently, we must also take account of the number of days that the prevailing repo rate and the new repo rate affect the current contract (see the appendix for calculations). The expected repo rate adjustment is then calculated as the difference between the repo rate adjustment and the surprise component.

In Figure 5, we see the calculated components for the monetary policy decisions between 2003 and 2014. The red bars show expected repo rate adjustments, the blue bars the surprise components and the yellow circles the actual repo rate adjustments. The diagram shows, for example, that the interest rate increases the Riksbank made in 2006-2007 were largely expected by market participants. In contrast, during the financial crisis of 2008-2009, the Riksbank, on several occasions, cut the repo rate beyond what the market participants had expected, which is shown by the blue bars. The Riksbank has also surprised the financial markets on a couple of recent occasions. Among other things, the financial markets expected the Riksbank to cut the repo rate by 25 basis points at the monetary policy meeting in July 2014, but the Riksbank instead decided to cut the repo rate by 50 basis points on this occasion.

\(^\text{12}\) The adjustment is measured between 09.15 and 12.15.
**ECONOMETRIC MODEL THAT CAPTURES INTEREST RATE MOVEMENTS IN CONJUNCTION WITH EXPECTED AND UNEXPECTED REPO RATE ADJUSTMENTS**

To measure how repo rate adjustments affect the general level of interest rates, we use a simple econometric model in which we estimate how different interest rates are affected by a repo rate decision. See Equation 1.

\[
\Delta R_i = \beta_1 \Delta r_{\text{expected}}^i + \beta_2 \Delta r_{\text{unexpected}}^i + \beta_3 \Delta R_t^* + \epsilon_i
\]

In the model, we include both the expected and unexpected adjustments to the repo rate, \(\Delta r_{\text{expected}}^i\) and \(\Delta r_{\text{unexpected}}^i\). The hypothesis is that the market rates only react to unexpected decisions. This means that the estimated coefficients for expected repo rate decisions, \(\beta_1\), should be small and insignificant. In addition, we include a foreign variable, \(\Delta R_t^*\), which is an aggregate of the government bond rates in Germany, the United States, Norway and the United Kingdom. The aim of the variable is to capture the link between longer market rates in Sweden and international interest rates. The weights are taken from the competitiveness-weighted index KIX. The variable is only deemed to have an effect on market rates with longer maturities and is thus only included in estimates of bond rates with maturities exceeding one year. The maturity of the foreign interest rate corresponds to the bond rate that is estimated for Sweden. The model is estimated using OLS.

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13 If it is included in the estimates for the shorter interest rates, the coefficient is not significant.
DESCRIPTION OF DATA

We use data from 2003, which is the period for which data for the Stina contract is available. As we described earlier, the surprise component for the repo rate is calculated as the difference in the Stina rate shortly before and shortly after the publication of the repo rate decision. To estimate the model, data is used up until and including the monetary policy meeting in December 2014. One reason that we do not use data from 2015 is that, since February 2015, the Riksbank has employed alternative monetary policy measures in the form of government security purchases. Monetary policy in 2015 thereby differs, to some extent, from that conducted in the period 2003 to 2014. There are, of course, both advantages and disadvantages in including the later period in our estimations, but, as our main focus is on studying how repo rate adjustments affect other interest rates, we choose to exclude the period.14

The interest rates included in the quantitative analysis are those that we have studied in Figures 2-4, which is to say the rate on the three-month Stibor and a treasury bill, a five-year government bond rate, mortgage bond rate and swap rate, and the average deposit and lending rate for households and non-financial companies. To extend the analysis and capture any differences between maturities, we also include a two-year and a ten-year government bond yield in our analysis. For bond yields, we use zero coupon yields with fixed maturities which are interpolated with the assistance of the extended Nelson-Siegel method.15

Financial market statistics for deposit and lending rates for households and companies are only available as an average on a monthly basis. To capture the total effects of the monetary policy decision, the change in these rates is calculated as the difference between the average rate in the month before the repo rate decision and the month after the decision, which is the change over two months. Our assessment is that a part of the effect of monetary policy is missed when only the current month is examined, as the average for the month is also affected by the rate that applied prior to the decision. One disadvantage of using a longer window is that interest rates may have been affected by other factors and that we may thereby over- or underestimate the effects of monetary policy. For companies, we study interest rates for new loans and, for households, we use the interest rate for new mortgages. To a certain extent, interest rates for mortgages are also available on a daily basis in the form of the banks' listed mortgage rates. These normally give a good indication of how interest rates in financial market statistics are developing, but differ, to a degree, as the rates are reported before any interest discounts. Estimates based on these interest rates are included in the appendix.

As we have described earlier, there are advantages in using models with daily data, as it reduces the risk that effects on interest rates that are due to other factors are included. The disadvantage of more high-frequency data is that it is difficult to say whether the effects

14 For a more in-depth description of how purchases of government securities are deemed to have affected the economy, see, for example, Economic Commentaries nos. 11, 12 and 13 (2015).
15 For more information, see Svensson (1995).
will be persistent and effects that only arise over the longer term may not be captured. One method for extending the analysis in the model we use in this article is to study the change over a number of days. Consequently, in the appendix, we report results from estimates in which interest rate adjustments have been calculated as the difference between the interest rate on the day before a repo rate decision and the rate four days after the decision.

ADJUSTMENTS TO THE REPO RATE AFFECT OTHER INTEREST RATES

In Table 2, we see the result of the regression analysis. We can see that adjustments of the repo rate affect other interest rates in the Swedish economy. The coefficients for unexpected repo rate decisions are positive and significant for all interest rates. For longer market rates, the coefficients for expected repo rate decisions are also small and not significantly separated from zero. This corresponds with the hypothesis that market rates should only react to new information.

Table 2. One day’s change in interest rates due to repo rate adjustments according to equation 1

<table>
<thead>
<tr>
<th>Interest Rate</th>
<th>Expected</th>
<th>Unexpected</th>
<th>KIX Rate</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stibor, 3 months</td>
<td>0.35 (0.04)***</td>
<td>0.77 (0.09)***</td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>Treasury bill, 3 months</td>
<td>0.17 (0.03)***</td>
<td>0.82 (0.06)***</td>
<td>0.83</td>
<td></td>
</tr>
<tr>
<td>Government bond yield, 2 years</td>
<td>-0.03 (0.03)</td>
<td>0.49 (0.08)***</td>
<td>0.38 (0.20)*</td>
<td>0.46</td>
</tr>
<tr>
<td>Government bond yield, 5 years</td>
<td>-0.01 (0.02)</td>
<td>0.32 (0.06)***</td>
<td>0.71 (0.13)***</td>
<td>0.52</td>
</tr>
<tr>
<td>Government bond yield, 10 years</td>
<td>-0.02 (0.02)</td>
<td>0.20 (0.05)***</td>
<td>0.82 (0.11)***</td>
<td>0.56</td>
</tr>
<tr>
<td>Mortgage bond yield, 5 years</td>
<td>0.02 (0.02)</td>
<td>0.39 (0.06)***</td>
<td>0.62 (0.14)***</td>
<td>0.56</td>
</tr>
<tr>
<td>Swap rate, 5 years</td>
<td>-0.03 (0.03)</td>
<td>0.34 (0.06)***</td>
<td>0.63 (0.14)***</td>
<td>0.45</td>
</tr>
<tr>
<td>Lending rate, household¹</td>
<td>0.93 (0.08)***</td>
<td>1.28 (0.18)***</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td>Lending rate, corporate¹</td>
<td>0.88 (0.08)***</td>
<td>1.53 (0.20)***</td>
<td>0.84</td>
<td></td>
</tr>
<tr>
<td>Deposit rate, household²</td>
<td>0.62 (0.05)***</td>
<td>0.93 (0.12)***</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td>Deposit rate, corporate²</td>
<td>0.76 (0.08)***</td>
<td>1.26 (0.18)***</td>
<td>0.82</td>
<td></td>
</tr>
</tbody>
</table>

Note. *** indicates significantly separated from zero on the 1-per cent level, * indicates significantly separated from zero on the 10-per cent level, standard deviation within parentheses.

1. Two months’ change since 30 September 2005.

SHORT-TERM MARKET RATES MOVE IN LINE WITH REPO RATE ADJUSTMENTS

The upper lines in Table 2 report the impact of a repo rate adjustment on the three-month Stibor and three-month treasury bill. Both these rates are known as money market rates, which mean that they are short-term market rates. They should thus be priced on the basis of expectations of the repo rate over the next three months and expected monetary policy decisions should be reflected in the rate. However, in the table, we can see that expected repo rate adjustments also have a significant effect on these rates, particularly the Stibor rate. This is expected to rise by just over 3 basis points when the repo rate is expected to be raised by 10 basis points. The corresponding figure for the treasury bill is almost 2 basis points.
One explanation for why the parameter for expected repo rate adjustments is significant and relatively large for Stibor may be that this rate is not traded to a particularly large extent. Stibor is primarily a reference rate that the banks quote on a daily basis and, historically, there have been certain frictions on this market.\textsuperscript{16} This is partly linked to the shortage of liquidity for three-month maturities, but also to a lack of transparency when the banks determined the rate. However, this should be less of a problem after 2012, when the Riksbank carried out a comprehensive investigation of Stibor. The investigation revealed a number of deficiencies in the Stibor framework, which led the Riksbank to make recommendations on Stibor to the banks in the Swedish banking system. In a follow-up in 2014, the Riksbank made the assessment that the banks had fulfilled the recommendations.\textsuperscript{17} As regards the treasury bill, it is likely that the relatively low liquidity can provide an explanation for the expected repo rate adjustments seeming to have an effect.

The coefficients for expected repo rate adjustments are also clearly smaller than the coefficients for unexpected repo rate adjustments. For both Stibor and the treasury bill, the parameter is significantly separated from zero and the impact of an unexpected repo rate adjustment of 10 basis points is about 8 basis points. The interest rate level also seems to continue to be adjusted several days after the repo rate decision, as captured in Table A1 in the appendix, which shows the adjustment to the rates four days after the repo rate decision. For both Stibor and the treasury bill, the parameter for unexpected repo rate decisions is close to 1, which indicates that the shorter rates are adjusted approximately in line with the repo rate.

\textbf{THE REPO RATE ALSO HAS AN EFFECT ON LONGER MARKET RATES}

In Table 2, we can also see that estimates of long-term bond rates are in line with the hypothesis that only unexpected monetary policy decisions should influence the pricing of market rates. The parameters for expected repo rate decisions are small and not significantly separated from zero. In contrast, all rates react to unexpected decisions. We can also see that the effects of foreign interest rate fluctuations are significant to all rates, but only at the ten-per cent level for the two-year government bond yield. The table shows that unexpected repo rate decisions have a greater impact on rates with shorter maturities, while the opposite is true for the international interest rate fluctuations, where rates with longer maturities are affected more. The estimates show that the ten-year rate can be expected to rise by 2 basis points in the event of an unexpected repo rate rise of 10 basis points. Even if the effect may seem relatively minor, it is within the interval that similar studies indicate for US data. For example, Fawley and Neely (2014) have compiled a number of different studies made using US data, the result of which shows that the effects on a ten-year government rate vary from between 1 to 6 basis points, with the mean being between 3 and 4 basis points.

\textsuperscript{16} See Sveriges Riksbank (2012).
\textsuperscript{17} See Sveriges Riksbank (2014).
The impact also seems to be about the same for government bond yields, mortgage bond yields and swap rates with the same maturity. This indicates that repo rate adjustments do not have a major effect on the risk premium. The results in Table 2 are also supported by the results in Table A1 in the appendix, which shows how rates have changed four days after a decision. The coefficients are largely unchanged, which indicates that the effect of a changed repo rate is persistent.

**ADJUSTMENTS OF THE REPO RATE HAVE A GREAT IMPACT IN INTEREST RATES TO HOUSEHOLDS AND COMPANIES**

Finally, Table 2 shows that monetary policy has a significant effect on interest rates to households and companies. The analysis differs from the one we made for market rates in that the result is for monthly data and the change has been measured over two months. The coefficients for both expected and unexpected repo rate decisions are significant, but unexpected adjustments have a slightly greater impact. The estimates show that lending rates to households move approximately in line with repo rate adjustments. The coefficients indicate that interest rates are adjusted by 9 and 13 basis points respectively when there is a 10 basis point repo rate adjustment that is expected or unexpected. However, the standard error, which is reported within parenthesis in Table 2, shows that none of these parameters are significantly separated from 1, which indicates that lending rates to households are adjusted approximately the same as the repo rate.

In Table A2 in the appendix, we also present the results for listed mortgage rates, both for a three-month variable mortgage rate and for a fixed two-year mortgage rate. The results show that the listed mortgage rates only make marginal movements on the day that the repo rate decision is published. However, four days after the decision, the coefficients for expected and unexpected repo rate adjustments are in line with the results in Table 2. This supports the results obtained from monthly data and indicates that mortgage rates are adjusted more or less immediately after a repo rate decision.

Furthermore, in Table 2, we see that the impact on corporate lending rates is significant. The coefficient for unexpected repo rate changes is large, but, as with households, the standard error indicates that the parameter cannot be separated from 1. One explanation for the relatively large standard error in corporate rates in particular is that companies are a heterogeneous group and interest rates largely depend on which companies choose to borrow in the month in question. This means that there are generally larger fluctuations in interest rates for companies, which probably has an impact on our estimates. Finally, our results show that deposit rates for households and companies are also largely affected by the repo rate, and estimates suggest that most repo rate adjustments have an impact on deposit rates.

To sum up, the results show that different interest rates in the economy are strongly affected by adjustments to the repo rate. An expected increase of the repo rate by 25 basis points typically leads to short-term market rates and interest rates for households and companies rising more or less in step with the repo rate increase. The impact on longer
bond yields is slightly lower, but historical correlations indicate that a five-year government rate normally rises by almost 10 basis points, while a ten-year government rate typically rises by about 5 basis points. The initial reactions in interest rates also seem to persist a few days after the repo rate decision.

INTEREST RATE FLUCTUATIONS ARE LARGELY IN LINE WITH THE EXPECTATIONS OF THE MONETARY POLICY DECISION FROM MARCH 2015

In this article, we have studied the transmission from the repo rate to other rates in the economy. The quantitative analysis we have described in the article may provide support both for monetary policy decisions and for analysing the effects afterwards. In this section, we analyse a specific repo rate decision and study how interest rate fluctuations in conjunction with the decision relate to our results.

The decision we have chosen to study is the monetary policy decision from March 2015. The reason we choose to study this meeting in particular is partly because we wish to avoid the dates included in the estimates and because it was an unusual decision. Among other things, the Riksbank decided to act between ordinary meetings, which surprised the financial markets. In addition, the Riksbank acted both by cutting the repo rate and by increasing purchases of government bonds.

In March, the Riksbank cut the repo rate by 15 points to -0.25 per cent and extended purchases of government bonds from SEK 10 billion to SEK 40 billion. The Riksbank did this after the Executive Board signalled, at the monetary policy meeting in February, that it was prepared, if necessary, to make monetary policy more expansionary, even between ordinary monetary policy meetings. Despite this, the financial markets were surprised by the decision. In Figure 6, we see that only 0.5 basis points of the cut of 15 basis points were expected according to the pricing of the Stina contract.
We can use our estimated coefficients to study whether the fluctuations in various interest rates in March were in line with our results. In Figure 7, we have compiled the results for market rates. The red bars show expected movements due to the adjustments of the repo rate, the yellow bars show the fluctuations that can be explained by international developments and the blue bars show the movement that cannot be explained by the historical relationship. The yellow circles show the actual movements on publication day. As can be seen from the figure, the model can explain a relatively large part of the movements in all market rates. The Stibor rate fell by 12 basis points in conjunction with the decision, which was largely in line with what could be expected according to our results. The downturn in the rate for a three-month treasury bill was initially somewhat smaller than could have been expected. However, data indicates that four days after the monetary policy decision, the rate had fallen by 16 basis points, which indicates that the rate was adjusted in line with the repo rate.

In conjunction with the decision, there were large movements in longer government bond yields in particular, where the ten-year rate fell by almost 15 basis points. The model can explain a certain part of this movement, but the reaction was greater than could have been expected give the adjustment of the repo rate and international interest rate movements. One explanation for the large movements in the ten-year rate in particular is probably that the Riksbank extended its purchases of government bonds from SEK 10 to 40 billion, at the same time as it increased the limit for the maturity of the bonds that it could purchase from 5 years to 25 years. With the decision in March, bonds with ten-year

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18 The Stibor rate is determined every day between 10.30 and 11.00 through bidding. The monetary policy decision in March was published in the afternoon, which means that Stibor had already been determined at this point and, consequently, in this analysis, we use the change on the day after the monetary policy decision.
maturities were thereby also included in the Riksbank’s purchases, which probably made the rate fall further.

The five-year government rate is judged to have been affected by the Riksbank’s announcement of government bond purchases. This is because a relatively large part of the downturn is captured by the variable “other factors”, which can be interpreted as the effect of the Riksbank’s extended purchases. We also see that the five-year mortgage rate and the swap rate fell to about the same extent.

Figure 7. Movements in market rates in conjunction with the monetary policy decision in March 2015

Figure 8 illustrates the change in interest rates for households and companies, where the yellow circles show the actual change from February to April. According to our point estimate, lending rates to households should have fallen slightly more than they did. However, in March and April, the lending rate to households fell by 15 basis points, which was in line with the repo rate cut in March. At the same time, the lending rate to companies fell by more than 15 basis points, which was also slightly less than expected according to our point estimate, but was in line with our assessment that a change in the repo rate should have an impact on interest rates for households and companies close to 1. All in all, lending rates to households and companies thus seem to have fallen in line with expectations. This also means that, in principle, the repo rate cut had the same impact as normal, even though the repo rate was negative to start with.

We deem the limited movements in deposit rates to be a consequence of deposit rates already having been close to zero at the time of the decision (see Figure 5) and the banks, so far, choosing not to let deposit rates for households and most corporate customers become negative even though the repo rate had been cut.
Conclusions

In this article, we have studied the effects of monetary policy on the general level of interest rates. We have done this both descriptively, by studying how different interest rates have moved in relation to the repo rate historically, and quantitatively, by employing a model to estimate the initial effects on different interest rates in conjunction with a repo rate decision. Our analysis indicates that changes in the repo rate influence other interest rates in the economy. The impact is greatest on short-term interest rates, but a clear relationship can also be seen for longer-term interest rates.

The descriptive analysis shows that short-term market rates have a high level of covariation with the repo rate. The quantitative study supports this analysis, but shows that it takes a few days for interest rates to adjust to unexpected repo rate adjustments. In addition, certain interest rates also react to expected adjustments of the repo rate, contrary to the hypothesis that market rates should continually be adjusted in response to new information and that expected repo rate adjustments should thus already be priced. One explanation for this could be that liquidity and trade in these rates is relatively low, meaning that the adjustment takes place slightly more slowly than expected.

The covariation between the repo rate and the longer market rates is slightly lower than it is for the short-term rates, which can be explained by the longer rates also being steered by factors such as expectations of the future repo rate, credit and maturity premiums and the development of financial markets abroad. The descriptive analysis nevertheless shows a relatively high level of covariation with the repo rate and the correlation between
the repo rate and a five-year government rate is about 0.5. The quantitative study also shows that unexpected repo rate adjustments have a significant effect on longer market rates and the effect also persists a few days after the monetary policy decision. Neither do longer market rates react to expected repo rate adjustments. The results indicate similar movements in a government bond yield, mortgage bond yield and swap rate with the same maturity, which indicates that adjustments of the repo rate do not affect the risk premium. Our estimates for government bond yields with different maturities also confirm that the impact of adjustments to the repo rate decreases with maturity and, instead, international developments become of greater significance.

Finally, our analysis shows that the repo rate has a close relationship with interest rates for households and companies. The estimates in our quantitative analysis demonstrates that interest rates are normally adjusted in line with repo rate adjustments. In addition, when we study the effects of the monetary policy decision from March 2015, we can also note that the impact on lending rates for households and companies was the same as previously, even though the repo rate was negative to start with. This means that the impact of the repo rate adjustment was not significantly changed by the fact that the repo rate was already negative. On the other hand, we note less of an impact on deposit rates, which we deem depends on the banks so far having wished to avoid introducing negative deposit rates for households and most corporate customers.
References


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Appendix

CALCULATING MONETARY POLICY EXPECTATIONS BY USING ‘STINA’ CONTRACTS

Equation 1 shows how the surprise component is calculated, where $t$ represents publication date, $\tau_1$ is the number of days the contract has run before the implementation of the new repo rate$^{19}$ and $\tau_2$ is the number of days left of the contract's maturity after the implementation of the new repo rate. The expected repo rate adjustment is then calculated as the difference between the actual adjustment of the repo rate and the surprise component (see equation 2).

\[
\Delta r_t^{\text{unexpected}} \approx \left[ \frac{r_t^{\text{Stina}} - r_{t^-1}^{\text{Stina}}}{\tau_1 + \tau_2} \right] (\tau_1 + \tau_2) - \Delta r_t^{\text{repo}}
\]

(1)

\[
\Delta r_t^{\text{expected}} = \Delta r_t^{\text{repo}} - \Delta r_t^{\text{unexpected}}
\]

(2)

Table A1. Change in interest rates due to repo rate adjustments, 4 days after repo rate decision

<table>
<thead>
<tr>
<th></th>
<th>EXPECTED</th>
<th>UNEXPECTED</th>
<th>KIX RATE</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stibor, 3 months</td>
<td>0.40 (0.04)***</td>
<td>0.90 (0.09)***</td>
<td>0.83</td>
<td></td>
</tr>
<tr>
<td>Treasury bill, 3 months</td>
<td>0.22 (0.03)***</td>
<td>1.02 (0.08)***</td>
<td>0.82</td>
<td></td>
</tr>
<tr>
<td>Government bond yield, 2 years</td>
<td>-0.06 (0.04)</td>
<td>0.52 (0.10)***</td>
<td>0.82 (0.11)***</td>
<td>0.47</td>
</tr>
<tr>
<td>Government bond yield, 5 years</td>
<td>-0.05 (0.03)</td>
<td>0.29 (0.08)***</td>
<td>0.76 (0.06)***</td>
<td>0.65</td>
</tr>
<tr>
<td>Government bond yield, 10 years</td>
<td>-0.09 (0.03)***</td>
<td>0.17 (0.06)***</td>
<td>0.84 (0.05)***</td>
<td>0.77</td>
</tr>
<tr>
<td>Mortgage bond yield, 5 years</td>
<td>-0.07 (0.05)</td>
<td>0.53 (0.12)***</td>
<td>0.58 (0.10)***</td>
<td>0.33</td>
</tr>
<tr>
<td>Swap rate, 5 years</td>
<td>-0.10 (0.04)***</td>
<td>0.32 (0.09)***</td>
<td>0.77 (0.08)***</td>
<td>0.58</td>
</tr>
</tbody>
</table>

Note. *** indicates significantly separated from zero on the 1-per cent level, ** indicates significance on the 5-per cent level, * indicates significance on the 10-per cent level, standard deviation within parentheses.

Table A2. Change in listed mortgage rates due to repo rate adjustments, daily change and 4 days after repo rate decision

<table>
<thead>
<tr>
<th></th>
<th>EXPECTED</th>
<th>UNEXPECTED</th>
<th>R²</th>
<th>EXPECTED</th>
<th>UNEXPECTED</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortgage rate, 3 months</td>
<td>0.08 (0.01)***</td>
<td>0.01 (0.03)</td>
<td>0.37</td>
<td>0.62 (0.05)***</td>
<td>0.87 (0.11)***</td>
<td>0.85</td>
</tr>
<tr>
<td>Mortgage rate, 2 years</td>
<td>0.04 (0.01)***</td>
<td>0.05 (0.02)***</td>
<td>0.32</td>
<td>0.16 (0.04)***</td>
<td>0.67 (0.10)***</td>
<td>0.57</td>
</tr>
</tbody>
</table>

Note. *** indicates significantly separated from zero on the 1-per cent level, ** indicates significance on the 5-per cent level, * indicates significance on the 10-per cent level, standard deviation within parentheses.

$^{19}$ A Stina contract traded on day $t$ corresponds to the expected interest rate on the Stibor T/N rate from day $t+2$ until the contract matures. Implementation day is the first Wednesday after publication date.